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MACHINERY:

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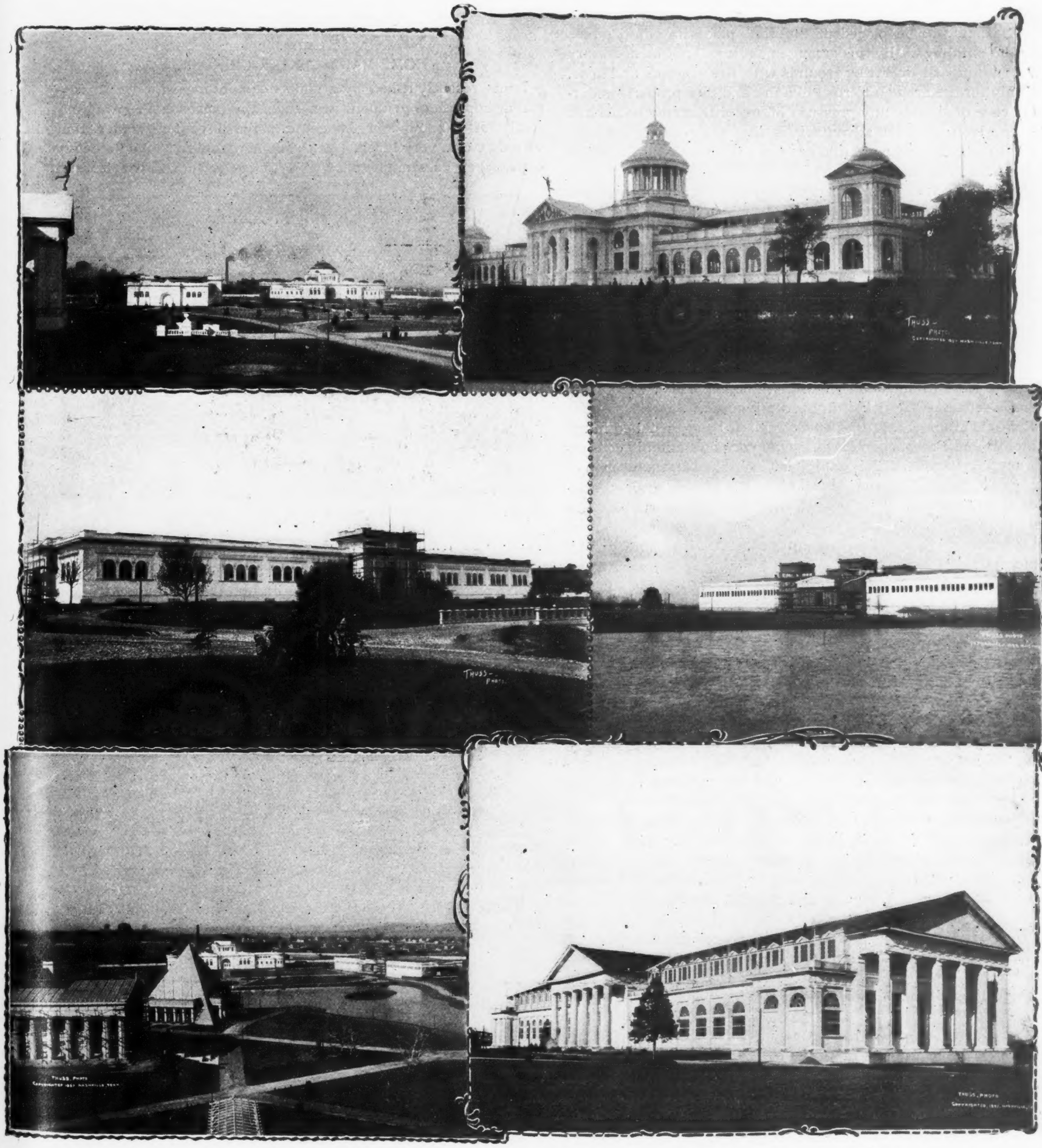
A PRACTICAL JOURNAL FOR MACHINISTS AND ENGINEERS
AND FOR ALL WHO ARE INTERESTED IN MACHINERY:

MACHINERY.

VOL. 3. March, 1897. No. 7.

ADVANCE NOTES OF THE NASHVILLE EXPOSITION.

THE Tennessee Centennial and International Exposition is being pushed forward with much vigor. All the large buildings are completed and are ready to receive exhibits, among them being Minerals and Forestry, Commerce, Fine Arts, Women's, Transportation, Agriculture and Machinery Hall. The floor in the latter building is not yet laid, awaiting the com-



ADVANCE NOTES OF THE NASHVILLE EXPOSITION.

GENERAL VIEW.
TRANSPORTATION BUILDING.
GENERAL VIEW

COMMERCE BUILDING.
MACHINERY HALL.
MINERALS AND FORESTRY.

pletion of the foundations for engines and machinery, also the putting up of the line shafts. The boiler-house is separate from machinery hall, and is fairly well advanced. The frame of the Negro building is up, and the work on that structure is being rapidly pushed forward to completion. The Memphis building and auditorium are also completed. Most of the grounds are in good shape, especially roads and paths. The electric wiring has been done in all the buildings that are completed. The water and fire mains are all laid and the fire pumps have been installed. There consists of two double-acting Worthington pumps, with a capacity of 50,000 gallons of water per hour. The fire system is quite original, as the pumps are centrally placed in the grounds near the lake, and they will be kept ready or in action all the time, giving a constant pressure in the main discharge-pipe, which runs all over the grounds and in close proximity to all the buildings; fire hose and fire hydrants will be placed at different places in the grounds near the buildings. By this arrangement it will not be necessary to be running all over the grounds with fire engines and hose, but only for the firemen to rush to a fire and by a properly understood code of signals, any pressure of water that may be desired can be given; another advantage is that the pump house is so located that those who are in charge can see nearly all the buildings on the grounds.

The boilers have been arranged for, and consist of four 500 HP. and two 250 HP., making a total of 2 500 HP. There will be about 3,000 HP. of engines in operation or reserve. Arrangements have been made for three 400 HP. Westinghouse Single-Acting Compound engines, which are expected very soon; also one 500 HP. Porter-Hamilton Corliss engine, and a 500 HP. Frick Eclipse-Corliss engine; the others are still under discussion. The boilers are the Morrin Climax Safety Water-Tube, manufactured by the Clonbrock Steam Boiler Co., Brooklyn, N. Y.

The power-house will be entirely separate from machinery hall, and close to the boiler-house, which is made of sheet iron, thereby reducing the risk of fire to a minimum.

Exhibits are now arriving, and some are being installed in the Minerals and Forestry building. One very fine exhibit consists of a marble Pagoda. This exhibit was supplied by the women of Knoxville, Tenn., and consists of all of the various grained marbles of that section. It is beautifully finished, all parts having a very high polish and, as a whole, is a magnificent exhibit; the installation of this is about completed. Another fine exhibit which is now installed in the same building, is a monolith and globe, supplied by the Southern Marble Co., of Gorgia. It consists of a large piece of marble weighing 50 000 pounds, with the marble globe mounted above; this globe is four feet in diameter and beautifully finished, and while observing it—one is struck with the simplicity of design, yet realizes the beautiful effect of simplicity and grandeur combined.

The Southern Marble Producers Co. of Knoxville, Tenn., have also some exhibits now in the building, and more yet to come. There is also a large slab of granite from the Mount Airy Granite Co., Greensboro, N. C., which is 28 feet long by 8 feet wide and weighs 32 000 pounds; it is a magnificient specimen. Another fine specimen of granite which is now here and will be erected on end within a few days, is a shaft or granite from Stone Mountain, Ga., supplied by Venable Brothers, Atlanta, Ga. It is 36 feet long, 4 feet square at the butt, and 30 inches at the top or small end. This shaft is in its rough state, just as it was split from the mountain side and is square and parallel on all sides; no other tools have been used upon it than drills and wedges. It weighs 65 000 pounds, and will be a nice piece of work to put up on end. It will be placed near the Minerals and Foresty building, fronting the lake. H. M.

Exposition Grounds, Nashville, Tenn.

* * *

THE following extract from a dispatch to one of the leading dailies would be amusing were it not that something like it is so common as to be nauseating. The dispatch is all about the breaking of a locomotive piston-rod—*the* piston-rod the dispatch has it—and concludes: "They were soon running on schedule time. Conductor Baldwin was in charge." Conductor Baldwin is probably an estimable individual, but what strikes the reader of ordinary intelligence is just what he had to do with getting that train running on schedule time. If the dispatch had said that Engineer Rustler and Fireman Schneider hustled around, got the piston out or chocked, the valves disconnected and blocked to cover the ports, and the train running only a half hour late, or words to some such effect, it would quite likely have conveyed some information, so far as personality is concerned. Something like this would probably have covered the case of the conductor: "Conductor Baldwin greatly expedited matters by complacently smoking a cigar, which a thoughtful passenger tendered him, and keeping away from old Rustler and young Schneider, while they were getting ready to run." But that is not the way the thing goes. When the machinery of the modern steamship or the locomotive meets with some slight mishap, it's always the Captain or the Conductor that sets things going again, although they in all probability know just as much about the matter as the Choctaw Indian knows of Greek verbs.

Great is the man who gets at the head. H

* * *

EVERY-DAY SHOP SUBJECTS.—4.

CHIPS.

HOME-MADE CENTER-GRINDER.

I was recently asked by a shop acquaintance who works in a small shop where grinders and such appliances don't grow very freely, if I knew how he could make a center-grinder that wouldn't cost very much, (for the owner wouldn't stand a heavy expense) as he wanted to be able to use hardened centers and

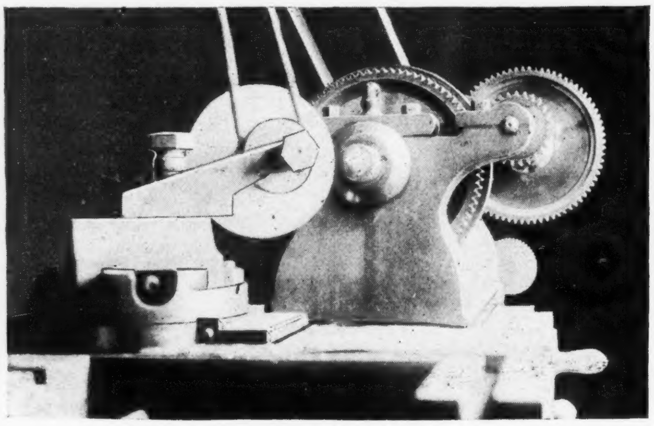


FIG. 1.

grind them true while in place. I told him of a grinder I made years ago in a shop similar to his, and which worked very nicely, didn't cost much and did lots of work besides grinding centers.

I happened to be in the old shop a few months ago, and seeing the grinder in place on my old lathe, I photographed it for future reference, hardly expecting it would be called for so soon. Fig. 1 shows it in place on a 13-inch Blaisdell lathe, fitted with a compound rest, in fact, if this kind of a rest had not been used, a different arrangement would have been necessary to give the

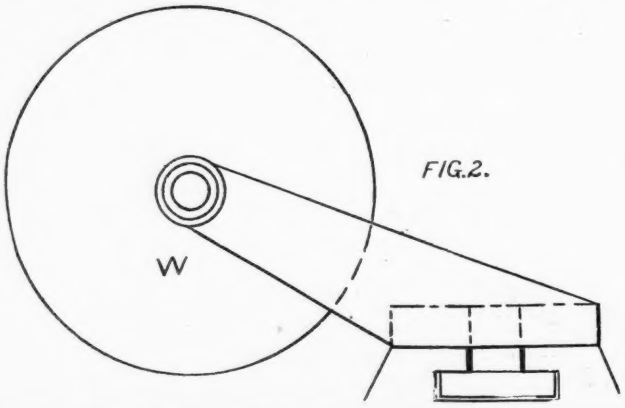


FIG.2.

wheel the right movement for grinding a 60 degree angle center. This gives a general idea of its application and will be referred to later.

Sketches 2 and 3 leaves little to be explained regarding its construction; Fig. 2 giving a side view of wheel W and end of frame; Fig. 3 a cross section through bearings and pulley. The bearings are cones; the shaft not touching in the casting. The right-hand cone N, has the hex on its outer end, and is threaded on the shaft for adjustment the nut *c* locking it at any desired point. The left-hand cone is solid with inside collar for wheel, being forced on the shaft. Wheel is held at *w* in usual way. The pulley

shown is for 1 inch flat belt, which is preferable to the round ones usually used, though the slip of the round belt may some time prevent driving the wheel in a cut which would draw the temper of the tool being ground, but care will prevent this.

The over-head drive consisted of a 12 inch wooden driver about 4 feet long which had been used in some textile machine and was

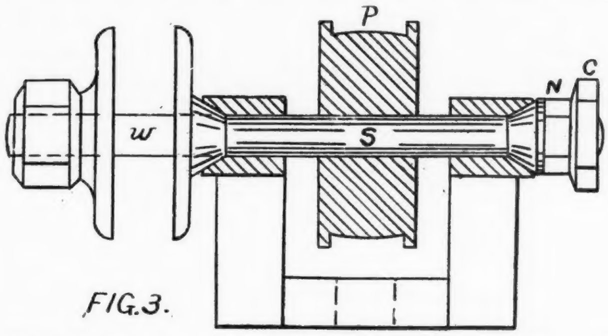


FIG. 3.

obtained cheap from a second-hand machinery dealer. The pulley on grinder was 2 inches in diameter, and as the wheel was 6 inches, it had to make a little over 3 500 turns a minute to get 5 500 feet surface speed, as advised by makers. This required

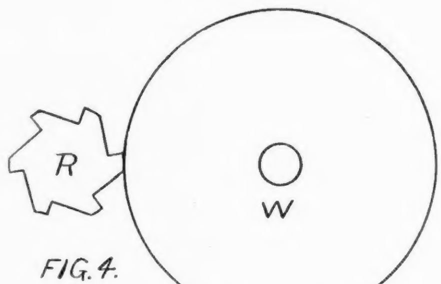


FIG. 4.

FIG. 5.

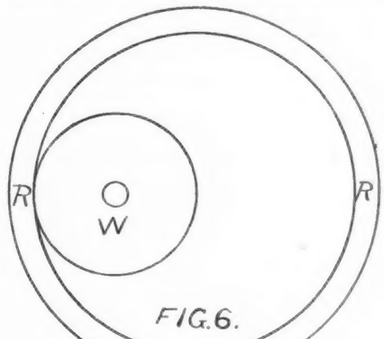


FIG. 6.

the driver to run one-sixth as fast or nearly 600 revolutions per minute. It was a cheap rig and one that did lots of work.

For grinding centers, after hardening, put it in a live spindle, (marking its position if necessary to always put it in the same way, and it usually is), swing your compound rest to 30 degrees each side of the center line and with your spindle revolving *backwards*, pass the wheel back and forth over the center until all the spring has been taken out of it and it is true. By running the work backwards you virtually increase your grinding speed, and I usually run the work backwards at a fair speed. It's a short job to true up a lathe center with these grinders, and no one who always uses a soft center can half appreciate them. Give me hard centers every time.

As should have been remarked before, the grinder-frame should be of the right height to bring the wheel spindle or shaft to the same height as the lathe spindle, or else the grinding on taper work, will not be satisfactory, and the center ground to 60 degrees by the index will not be 60 degrees in reality, if the wheel center is not exactly the same height as the lathe spindle, for the same reason that a lathe will not turn the same taper at two successive cuts, unless the tool point is at the same height as lathe centers. If any one doubts this, a fair trial will readily prove it, or the Editor can explain the "why" of it if asked. It will be found that the grinder can be put to many uses. Reamers, both fluted and square, can be readily ground, and ground truly, which is next to impossible with hand grinding. Figs. 4 and 5 show the *first* grinding of reamers of these types. Fluted reamers should be afterwards ground on the flat or radial side, but with the square reamer this cannot be done.

Internal grinding will not be needed often, but can be readily done by a little careful planning; the idea is given in Fig. 6.

Where you have a spiral fluted reamer to grind, the scheme shown in Fig. 7 will come in handy and is cheap to make. The arm is made to take in any size shank you are likely to have, and the clamp can be varied to suit requirements. The weight holds the radial side of slot against the stop S, and as this stop moves with the carriage it keeps the reamers in the right position for being ground at all points. A spring can be used, if desired and the arm placed on the right side of the wheel, which may be more convenient.

NOTES FROM A ROVING CONTRIBUTOR.—7.

CONCERNING CLUTCHES—REVERSING GEARING—COMPLETED INVENTIONS—LATHE COUNTER-SHAFTS—MACHINE TOOL-MAKERS—THE GENIUSES OF WAR SOME OTHER MATTERS.

All machines not permanently connected to the impelling power are started and stopped by clutches of some kind. The name is wonderfully comprehensive, if we consider the function and then include the thousand and one devices that do or should come under the head of "clutches."

In former times "clutch" meant only a positive grab plate or jaws—the slam-bang type it may be called—used on lathe counter shafts and like places that, by all rules, should have gone to pieces each time they were engaged, or "thrown-in," as the shopmen call it. Still, these old clutches went on year after year, and continue to go. Sometimes a jaw or a quadrant of a pulley would come down on a fellow's head, but that was expected, and at the worst, never formed a sufficient excuse for the kind of frictional contrivances that have succeeded.

The pursuit of a fad in mechanics is a disease, as erratic as in politics or religion. It has a rise, a culmination and decay, spread over years like the fashions, but more persistent. The functions required for lathe counter shafts are all well represented and attained in a more perfect manner by narrower belts and pulleys moving at a high speed, but no one thought of that. Right along-side of the lathes were planing machines reversed a hundred times to once of the lathes, and as promptly as friction clutches could do, but the ten feet from the floor to the ceiling shut out the comparison.

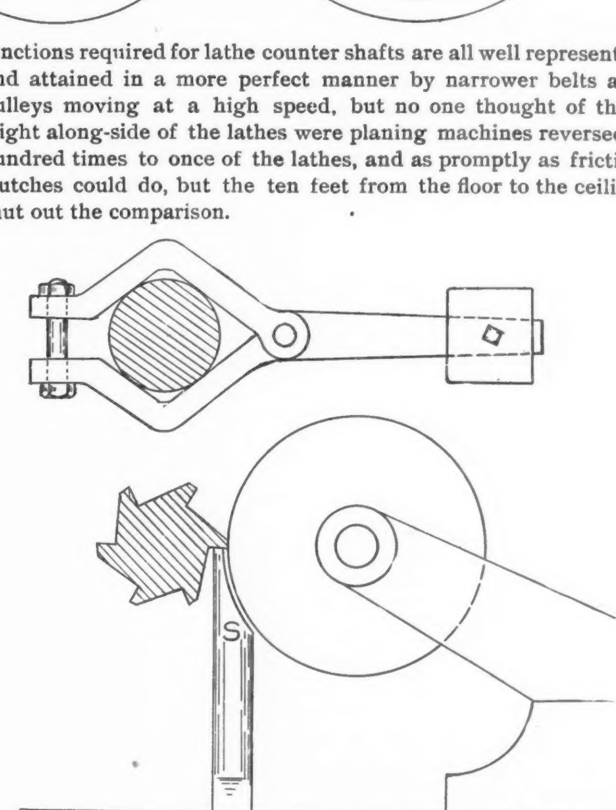


FIG. 7.

Of all reversing machines ever contrived, a metal planing machine makes the most severe demand on clutch motion, but there is never any difficulty, only some one without fear or precedent applies a new kind of clutch to these machines ; then trouble begins. But in order "to get at the bones of this thing," as the Scotch say, let us go back a little way and proceed in regular order.

There are certain characteristics of clutches that admit of what

Thomas Buckle, the historian, calls "generalization," that is, are reduceable to terms and words that convey a mode or principle of operating; also expressible in symbols algebraically, which latter clutch-makers, most of them cannot read or understand. Let us try the word "method;"

1. All clutches must involve a "yielding function" derivable either from friction or elasticity; that is, from sliding surfaces or resillient springs. The latter may be an air-cushion, stretching of belts, the torsion of shafts, or in any other manner to produce yielding action.

2. In all clutches, the intensity of action and strain on the operating surfaces, is inversely as the radius from the center of rotation to these surfaces.

3. All clutches should have dual or operating elements, balanced across the center of rotation, so as to avoid centrifugal and other disturbances, permitting only inherent strains, that is, strains within the clutch and balanced.

4. The actuating surfaces in all friction clutches should be parallel to the axis of rotation, or, if radical, very narrow. This means that the velocity should be uniform over the acting surfaces.

5. In all traction or frictional clutches, the rubbing faces that slip should be of dissimilar material, polished metal on hard wood, leather or other elastic material.

I might go on and multiply these axioms, but there are quite enough for the reader's patience, besides, we will come to all these propositions again, presently, when some more "generalization" is worked out.

Clutches, of all mechanical expedients, admit of the widest variation in contriving, and for this reason are the most difficult to bring within a standard construction. A blacksmith's anvil was at once, as a thousand years of precedent will prove, brought down to a standard; made with a horn, razee corner, a hole for hardies and other implements, finished and laid away at rest beyond the contriver.

So were the plow, wheelbarrow, and many other things more complicated, but there is no rest in clutches. Every person wants one of their own, and nine out of ten made, are the result of "contriving" without any thought of the learned postulates just laid down above.

To prove that there is the wide diversity of practice. The case is hopeless, and no doubt half a century hence, there will be a continuous crop of clutches the same as the present time. There is a kind of relapse going on now, especially in England, where the radius has been shortened down and the required pressure intensified until friction clutches are much like a split nave, or hub of a wheel or pulley. By reducing diameter and increasing pressure, something is saved in expense and often a good deal of inconvenience, but endurance is reduced until no one can see how a clutch of the kind will last to pay for itself. Perhaps they do not, but like the great rifle guns, have a life limited to a few score of rounds.

It will be easy for the reader to see that I am dodging constructive features. If once launched into that, this copy would be blue-penciled into oblivion. There would be no end, so to raise the main issue, here is another proposition:

6. Of all friction clutches ever invented, a shifting belt is the most perfect for all cases where the tractive power is sufficient, and these cases include nine-tenths of the whole.

There are ten of this kind of clutches to one of any other form, and they are so familiar as not to be even thought of as clutches at all, but they are so, in every sense.

They drive by friction or the traction of surfaces, gradually applied by increasing the area in contact; the acting surfaces are removed from the center as far as possible; the materials in contact are hard polished metal and leather, one of the best combinations known. The power required to apply the clutch is insignificant—a mere touch, and when applied, is held in place inherently; a simple shifting-fork thus represents a lot of complication required in other clutches. The pressure or tractive force is at control and regulated by the most simple means. They have lasted for a century, and, as before stated, are in use, ten to one, over all other contrivances of the clutch kind. Finally, a shifting belt, or band, which is the better name, fills all the conditions indicated by the learned analysis that has been given but with limitations in certain cases.

Now, the question comes, why all this scheming to supplant shifting belts with other frictional contrivances? There are certainly many and sufficient reasons in the case of a large amount of power; when room is wanting; in case of exposure to dust and water; when positive motion is required and, perhaps, in other places. Still, there are hundreds of instances where shifting belts are substituted by less perfect apparatus for the same duty. One of these is for lathe shafts, and the common reason assigned is that the belt is too slow and not exact enough. This is a problem of the belt's speed, or the diameter and width of pulleys. Look at a planing machine with proper belt shifting apparatus; the tools can be stopped and reversed in a hole the diameter of which is only the width of the tool. A clutch-lathe shaft cannot do that, or near do it. Then, look at the frequency and severity of the reversing in planing, the momentum, inertia and other resistances are double as much as for even the largest lathes.

This clutch matter has lead to a tilt with machine tool-makers. So much the better. I have been preparing for this privileged class of machine makers, and am not afraid of the issue; have indeed for some time been spying out vulnerable spots in their practice. There will be a free field, too, because the Professor does not know the difference between a shaping machine and a wheelbarrow, except as to computable strains, and these in a machine tool are a matter of no consequence. It is the "accidental" strains that constitute premises for design, and of these the Professor is oblivious.

A war of ideas and words is always profitable. If not to the combatants—then to the other people, and herein differs from a war to "prove a proposition by killing people," a relic of barbarism that has come down from a time when our species walked on four feet and gnawed bones.

It is but fair, however, to admit that the machine tool makers are not chief sinners in this matter of clutches. The best makers have always provided their lathes with shifting belts, but often—if not oftenest, with bands twice too wide and twice too slow in movement to act promptly; also, some of them send out such over-head shafts with two wide, loose pulleys, and a narrow fast pulley in the middle—all being of the same diameter.

I presume some will dispute this and thus make place for a bet or an affidavit, both of which should be required to make a good mechanic believe that a lathe countershaft was ever made with a "single face" fast pulley in the middle of two double-faced loose ones.

Knocking about one time in a foreign land in company with a local machine tool maker, we came upon a "Sellers" planing machine—not a "planer"—Heaven forbid the term. His attention was called to a bent rod ⅝ in. diameter that worked the belt shifting gearing. He said: "Look at that; why, if I made such a thing I would be considered a fool."

I started the machine, set the tappets wide, and asked him to move the rod by hand; this he did and then remarked: "That is nothing; the feed is not connected."

Then some of my American pride came out, and I told him that when a boy I remembered an old planing machine that operated its feed gearing from the tappets on the table, but no one in America had done such a thing in forty years past. He looked incredulous and left. The "forty years" was a lie, but "thirty" might go on a pinch.

Now, I ask any sensible, unprejudiced person, skilled in the mechanic arts, to go to a common Sellers' planing machine, take hold of the belt-shifting handle or rod, jerk it backward and forward; consider the time and accuracy of not only stopping and starting, but reversing also. Note the time, manner and ease of engagement and disengagement; the absolute certainty of action; the strains; concussion, or the want of it, and then consider that this clutch engages double; that it stops and starts two elements, on an average five times a minute, 7 000 times a day, 2 000 000 time a year, and is expected to last as long as half a dozen common friction clutches. It is the refinement, the ultimate and perfect example of friction clutch practice, and still dozens of people are hunting for something to displace this and like gearing.

I have no patience with these contrivers. If they would sit down and "think" a while, it would save the world a lot of expense and trouble. The basis of contriving should be a "want" of something new, or a "fault" for something old—not a morbid hankering for something novel.

A friend brought in, just when I was writing, a new friction clutch and with it an "analysis." It was the best one ever seen,

because he, as a careful student, had learned the logical method and qualified this method by a good many years of "shop."

He admitted candidly that it was inferior in many ways to a shifting belt, but said "my customers want clutches."

* * *

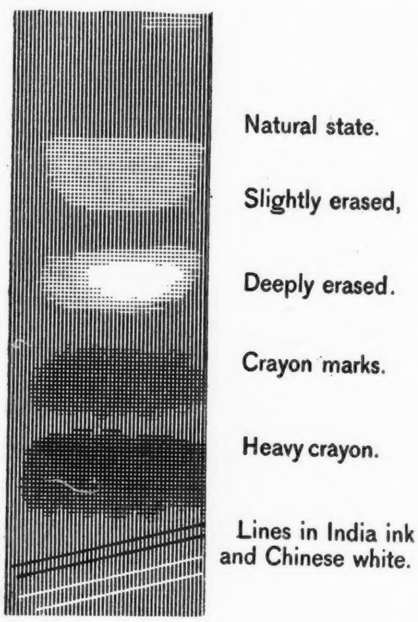
DRAWING ON GRAINED PAPER.

W. H. Sargent.

Among the many inventions of this ingenious age perhaps no device has been more universally adopted or given greater pleasure to so many people as the recent improvements in reproductive art.

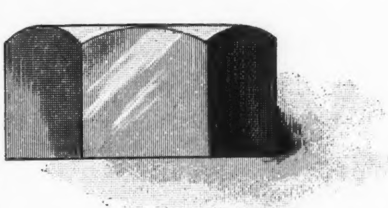
Most of the illustrations in the many magazines are now engraved by the photographic processes, either by the half-tone method from photographs or by zinc etching from line drawings. The commercial engravers, however, still exhibit a preference for wood engraving for such work as cuts of machinery and tools. Most of the work among the advertising pages of this paper appear to be wood engravings and of a high order. Such work costs money, and if some method could be devised by which a fairly good cut could be made by a less skillful and consequently cheaper man, many of our craft might be able to produce work for publication which their lack of skill now prevents them from doing.

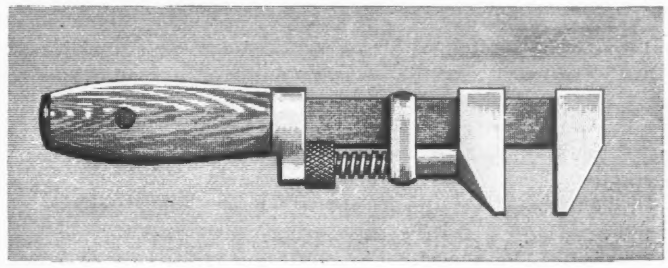
The use of grained paper will prove a help to many a draftsman who desires to produce a cut for printing purposes which shall have an appearance of finish which he is unable or unwilling to give by the slow process of nibbling away with the point of a pen. There are several varieties of this paper, which is also known as "autographic" or "stipple" paper. They all consist of a card-board with a heavy chalk-like coating, over which is printed an even tint of fine lines or dots, so that the lines may be partly or wholly erased for the lights and darkened for the shades.



Some of this paper has this "line surface" ploughed into furrows in one direction and printed with fine lines the other way. These lines follow down into the hollows and up onto the summits of the ridges which may be drawn upon, or with a sharp knife parts of the line may be erased, or by cutting deeper all may be removed, as shown in our illustration.

The method of making a drawing upon this paper is about as follows: Cut off a piece of the required size and mount on heavy board; the paper comes in sheets of about 14 by 22 inches, and is too brittle to handle unmounted; lay out the drawing on thin paper, about twice the size of the engraving desired, and transfer carefully by means of carbon paper. Make no lines which are not needed, as none can be erased. With a black wax-crayon or lithographic pencil rub in the medium shades and increase the pressure toward the dark part, the very darkest portions may be put in with pen and ink. With a sharp steel eraser remove the medium lights and afterwards the high lights, using a piece of fine sand-paper where there is considerable surface. White lines may be made with Chinese white, and it would be well to study a good wood engraving to see the use which is made of white outlines around many shaded parts and observe the crispness and brilliancy thus obtained. These drawings must be handled with considerable care, as the crayon is apt to "smut" and spoil the work. As the chalk surface will soil easily, the drawings are useless for shop or office work; they are only good for reproduction by the zinc-etching process, after which they may be printed in any press and on any paper. The etching process is inexpensive, costing about 10 cents per square inch, so that the cost of the cut is considerably less than by any other process.





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The case between Manning, Maxwell & Moore, representing the Shaw Electric Crane Co., and the Morgan Engineering Co., in the United States Circuit Court of New Jersey, known as the Shaw vs. Worthington case, has been decided in favor of the Morgan Engineering Co.

This case has been a long drawn out patent litigation, covering years of time, and the Morgan Engineering Co. are being warmly congratulated on their victory.

* * *

FOUNDRY TIME AND COST KEEPING.

George A. Webster.

Is it practical to know accurately the cost of work? Is it profitable to obtain this result at a moderate expense? These are familiar questions to every foundry man, and they are receiving more consideration as competition becomes sharper.

It is claimed by numerous men connected with the iron business, that a cost system with any degree of reliability is foreign to foundry work. A foundry foreman who is familiar with his business is supposed to be able to give a correct estimate for new work, and it is believed he should find no difficulty in obtaining, by estimate, a correct account of work already completed, thereby saving the expense of a cost system and adding something to the profits. Estimating on foundry work, either new or old, is a very unsatisfactory method of obtaining cost or prices, because of the new difficulties arising from each piece of work, even though it be two castings from one pattern.

By the system which I shall endeavor to outline, it will be seen that it is not only practicable to obtain correct results, but a profitable feature, and the expense, instead of diminishing the profits, enables the foreman, by use of a system, to so arrange his work as to increase them.

One extra clerk is all the office help that is required to keep the time and costs for a foundry employing about three hundred men. It is necessary for him to have an office close by the entrance to the works, and by which the men are to pass in going to and from work. He is also supplied with a check-board, upon which hang metal checks numbered from one to three hundred, and with sheets (day-sheets) 12 x 16 inches ruled into one inch squares, numbered to correspond to the check-board and checks.

Three books are necessary. First, an ordinary pay-roll; second, a casting-book, which contains the weight of all the castings, the mixture and weight of each day's charge, the amount of coal and wood used each day, and the weight of the sprues and pig-bed. All of these being entered under their corresponding heads, the different castings (loam, dry and green sand), and the number of each being kept separate. Third, the cost-book, which is the most important, and which contains entries, under each separate order number, of all the time of the different departments, core-makers, moulders, chippers, helpers and teamsters, as well as the separate weights, (under the proper head of loam dry or green sand) of each casting.

The method of keeping time, which is simple and effective, occupies about one hour a day. Every man, as he passes the time-keeper's office, is handed a check from the board. After

the whistle is sounded, a line is drawn across each square on the day sheet corresponding to the number of each check that is not called for, and it signifies that the man whose number is not taken is an absentee. Should he arrive late, he may be credited from the time his check is taken off the board. The checks are deposited as the men leave at the end of the session, and they are taken as they begin another.

As the orders for work arrive they are entered (at the main office) on an ordinary order-book and are given a number. The cost-clerk, each morning, fills out an order blank from this book and makes an entry of it on his cost book. It is then passed to the man in charge of the pattern room, who, after gettin‹ the pattern into shape for the foundry, places a sticker on it containing the order number. The order is then handed to the foreman of the foundry, and the pattern is placed on his platform, who after having the casting made, hands it to the weigher. After the castings have passed through the casting-room and have been cleaned, they are weighed and the weight of each is placed on the back of its respective order. This order is then forwarded to the time-keeper's office, where its number, the number of pieces and the weights, are entered on the casting-book, under their respective heads—loam, dry and green sand. The melter hands to the time-keeper, each morning, the weight of the previous day's charge, the amount of coal and wood, and the weight of the sprues and pig-bed, which are also entered on the casting-book. Thus, the footing of the castings made each day, and the iron melted, should come very near a balance after deducting about 6 or 8 per cent. for waste. This constitutes a check against omissions or over weights.

After the moulders have finished their work, the time-keeper, with his day-sheets fastened handily to a board, passes to each man and obtains from him the exact time he has been employed on each mould on his floor, placing it in the square on the day-sheet corresponding to the workman's check number.

The division of time into classes, according to the amount of wages each man receives, makes it necessary to employ some method by which the different classes may be distinguished. It is done by allowing a certain number of squares on the day-sheets for each class, viz :—First class moulders, 1 to 75; second-class moulders, 76 to 125; third-class moulders, (apprentices), 126 to 150; moulders' helpers, 151 to 225; first-class core-makers, 226 to 250; second-class core-makers, 251 to 265; melters, 266 to 268; melters' helpers, 269 to 275; yard hands, engineers, carpenters, gatemen, watchman and other extras, 276 to 300. The next duty of the clerk is to enter the time he has taken on the day-sheets into the cost-book, under the different classes of labor and the different grades of work. He also transfers from the casting-book the weights, denomination, and number of pieces of castings on each different order number, keeping the time employed in preparation under its separate head, because when the cost is figured, all preparation labor is figured at actual wages, while the direct cost is figured at average wages, and has a percentage added for profit. With the weights, labor, and cost of material on each separate order, the matter of figuring a cost is reduced to its simplest form.

To establish a permanent rate of wages by which to figure, the average of the different classes is found, and to it is added a percentage for profit. Ten first-class moulders (those receiving $2.50 per day and over), range from $2.50 to $3.00--the average being $2.75, to this add 20 per cent., which gives for first-class moulders wages $3.25. On the casting-book the cost of each day's melt is carried out, and the percentage of waste determined. It will be found that this percentage will vary perceptibly in accordance with the different mixtures.

The foreman of the core-room keeps a record of the core-sand used on each job, and it is figured in the cost at a given price for the different mixtures.

There are numerous other small details which arrive daily, but a clerk with a little experience in the foundry business can easily dispose of them, and so arrange matters as to facilitate the workings of the system.

Non-producing labor is always more or less necessary about a shop. This is taken into consideration by having all the time of such men charged to a letter. It is thus separate and the percentage is added to each order, thereby making each bear its proportional share of the expense of running the shop.

After completing an order, a cost-slip is made out and handed to the main office, which may read something like the following. The order as it arrives, is:—

"Make four castings from the patterns sent.

JOHN JONES, Boston."

THE SLIP.

Order No. 100. Name—John Jones,

Make 4 castings to his patterns.

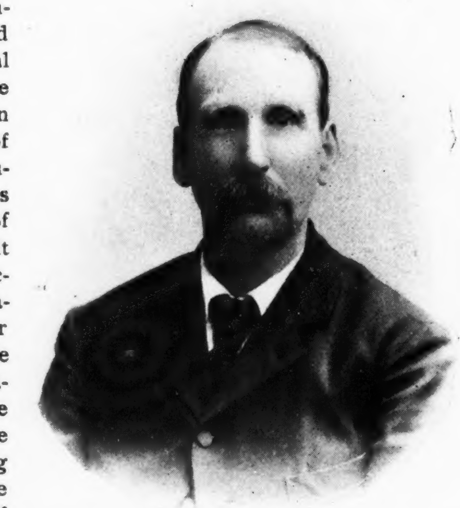
PREPARATION LABOR:—				
1st class moulding	2 hrs.	at 30c. =	$ .60	
Helpers	6 "	15c. =	.90	
Carpenter	1 "	22½c. =	.23	
Team	1 "	35c. =	.35	
1,500 lbs. iron at 1¼ + 6 p.c.		=	19.88	
				$21.96
1st class moulders	20 hrs.	at 32½c.		6.50
2d " "	20 "	25c.		5.00
Moulders' helpers	20 "	17c.		3.40
1st class core-makers	14 "	28c.		3.92
2d " "	8 "	23c.		1.84
Chippers	12 "	18c.		2.16
Carpenter (boxing)	2 "	23c.		.46
Teaming	1 "	70c.		.70
Lumber (crating)				.70
100 brick at $4.00 per M				.40
1 lbs. nails at 7c				.14
1 bbl. core sand at 14c				.14
6 500 lbs. iron at 1¼c. + 6 p.c				86.13
				133.45
Add 25 p.c. for expense				33.36
				166.81
(Cost, $0.23 lb.) Cr. By iron flask 1,500 at 1⅛				16.88
				$149.93

From this system monthly reports may be made out, showing the actual cost of the month's work, the actual receipts, the profit or loss on each separate order, and the profit or loss for the month or year. It has been applied with equally good results to factories operating iron foundry, brass foundry, pattern-shop, machine-shop, steel-shop, forge-shop and boiler-shop, and it can be so modified as to be very successful in yacht and ship-building yards.

* * *

COOLING SURFACE AND SIZE OF CENTRIFUGAL CIRCULATING PUMP FOR SURFACE CONDENSATION.

N. J. SMITH.



The extent of cooling surface for a surface condensing engine will depend upon the terminal pressure of the steam, as also upon the temperature of injection or circulating water. As applied aboard of steam vessels, it must take into account the temperature of the water where she is liable to sail; and to a stationary plant, the varying temperature of the circulating water caused by the different seasons of the year; and in each case must be amply large for the greatest temperature of circulating water liable to occur.

To find the cooling surface for any condition, per indicated horse power, use this rule: Multiply the square root of the terminal pressure plus 2, by .23 plus the two hundredth part of the temperature of the circulating water. Formula:

$$\left(.23 + \frac{T}{200}\right) \sqrt{P + 2}.$$

Using .7 as a constant multiplier of $\sqrt{P+2}$ will give the surface for circulating water at 95°, which will cover any case liable to occur.

Example: Vacuum by gauge, 26 inches; circulating water, 70°; indicated horse power, 3 000; what extent of cooling surface in square feet is required? A vacuum of 26 inches will balance 2.5 pounds pressure in condenser, then; $2.5 + 2 = 4.5$; $\sqrt{4.5} = 2.12$ $70 \div 200 = .35$; $.23 + .35 = 58$; $2.12 \times .58 = 1.23$ = square feet per indicated h. p., and $3\,000 \times 1.23 = 3\,690$ square feet cooling surface for given conditions; or, with a constant of $.7 = 4\,432$.

The quantity of circulating water will depend on the temperature of discharge from the condenser and circulating water, as also on the thickness of tubes in the condenser. The steam and circulating water should pass through the condenser in opposite directions. To find the minimum amount of circulating water to condense one pound of steam; rules: To 1 250 add 8 times the square root of the terminal pressure plus 2, from the sum subtract the temperature of the condensed steam; divide the remainder by the temperature of the condensed steam minus the temperature of the circulating water. This amount of circulating water can be increased any amount required by increasing the constant. Formula:

$$\frac{8\sqrt{P+2} + 1\,250 - T}{T - t}$$

Example: Temperature (hot well), 115°; steam per indicated horse power, 18 pounds per hour; required, the minimum amount of circulating water. $2.12 \times 8 = 16.96$; $1\,250 + 16.96 = 1\,266.9$; $1\,266.9 - 115 = 1\,151.9$; $115 - 70 = 45$; $1\,151.9 \div 45 = 25.6 =$ pounds circulating water to condense one pound of steam. $3\,000 \times 18 = 54\,000 =$ pounds of steam to be condensed, and $54\,000 \times 23.6 = 1\,282\,400$ pounds for 3 000 horse power.

To find the diameter of suction for the centrifugal pump. Every velocity of the periphery of the fans has a corresponding height at which it will raise and hold the water, and the theoretical velocity of the water at that height is 8.03 times the square root of that height per second; consequently the diameter of the pipe must be such as to admit that quantity of water through it at that velocity. The velocity of circumference of fans is 500 times the square root of the height, plus 550, and the diameter of suction pipe for any given amount of discharge is: Pounds discharged per hour divided by 7 470 times the square root of the height. Assume in this case a velocity of water through the pipe such as to require a head of 8 feet; then square root of $8 = 2.828$ and $7\,470 \times 2.828 = 21\,125.16$; 1 282 400 divided by 21 125.16 equals 6.07, and the square root of 6.07 equals 7.79 equals the diameter of suction pipe. This diameter of pipe will deliver about 20 per cent. more that theoretical amount, to allow for friction in the pipe and passages. For the velocity of circumference of the pump we must assume a diameter for the pump and a number of revolutions per minute to give the required velocity. Here the square root of 8 is 2.828, this multiplied by 500 is 1 414, to this add 550, and the sum is 1 964 feet per minute, the required velocity of circumference to maintain the head for the proper velocity of the water through the pipe. If we assume the diameter of the fans to be 4 feet, then the circumference will be 12.58, and the number of revolutions of the fan is 1 964 divided by 12.58 equals 156.1. In practice the cooling surface will be made as small as possible to save room, but which at the same time will require more circulating water, consequently a larger pump or quicker circulation, which can be obtained by running the pump faster.

The quantity of circulating water as obtained above is the minimum, and in practice would require to be considerably increased.

* * *

THE METRIC AND DECIMAL SYSTEM.

JOHN E. SWEET.

Some months ago I took occasion to differ with you upon a certain point and you seemed to take it so gracefully that I am disposed to differ with you again to the extent, at least, of arguing the case as to the advisibility of changing any of our weights and measures. Not on the usual ground taken that we cannot afford to change, but on a bolder one that no change proposed will make them better, nor could they be much improved if we were to start out anew.

To begin with, I insist that a 10-inch foot is not half as good a foot as a 12-inch one; I mean as a thing to use, and that as a tool, you cannot improve on the 2-foot rule for the class of industries it is largely used in—carpenters, masons, tinners, plumbers, machinists, for general measures, and a score of other industries. It's a convenient length; you can measure accurately; you measure a convenient distance at every step; and with any common one where the inch is divided into 16ths on one corner, 12ths and 10ths on others, you can divide the inch into nine different spacings without remainder; all useful except the five, and you can divide the foot into 21 or 22 different dimensions without remainder, half of these useful, and this is a feature as a tool that no system of decimal dimensions can approach.

As to dispensing with the yard, that would be as inconvenien to the dry goods merchant as to dispense with the 2-foot rule for the carpenter, though it is true that you could have a 4-foot yard with a 10-inch foot. But even then a measure corresponding about in length with the yard would be retained in spite of everything, because it is a convenient unit for cloth measure and the merchant can calculate faster in yards 3 feet long, than in feet. In other words, the unit is a convenient one for that class of work. Again, in our New York land measure, a chain is the unit and it is better than if smaller, besides as there is a lot of figuring in land measure, probably in proportion to the work as much as in anything, the whole thing is in the decimal system and at the same time commensurate with the foot. Ten chains make an acre and 100 links a chain. It is true that the quarter of a chain or a rod is 16½ feet, but that is exactly what comes of any decimal system, when you get a quarter you have some kind of a 2½ business, or have to add another figure to prevent it. The 16 ounces to the pound seems to the mathematician an awkward thing, but what could possibly be better for the grocer, and he is the man and not the mathematician or machinist that has to deal with them.

And it's time enough when the grocer wants 10 ounces to the pound to talk about the change.

About the wire and sheet metal gauges. The original Birmingham wire gauge was right when it was made, and is only wrong now because conditions and requirements have changed. It grew out of the fact that a wire rod could be drawn at the first draw from the rod to No. 1 size, and the next time to No. 2, etc, but in later requirements the gradations were not fine enough; so sheet metal gauges were made, and a Stubbs wire gauge where the gradations were so fine that the wire was drawn to any size, cut into 3 feet lengths and then gauged. If too large for one number, and too small for the next, it would go in either pile or the one it fitted the nearest. To get over the various gauges a new one has been adopted, based on the thousandth of an inch. It does not agree with anything but a micrometer caliper, and has the disadvantage of requiring a lot of figures to tell what one wants, and cannot well be memorized.

Were it not for the fact that all old gauges are numbered the new gauge would be perfect, by numbering the notches in their regular order, and as it will always require something to designate the gauge, it is possible that it would sooner become universal if numbered and designated D. G., as the Birmingham gauge is B. W. G.

This and all other propositions to change the well established weights and measures, which are the outgrowth of centuries and which are the survival of the fittest for the world, started with ten multiple and subdivisions which you propose to re-establish, seems to me to be this way: That the men who deal in ideas wish to dictate to the men who deal in things, that the mathematician wants to fix things for his convenience at the expense of the convenience of the workman, while there are a hundred workmen to every mathematician, and the mathematician gains nothing in money, while the workman will be put to millions of expense, and will not only receive no benefit but so long as our present books exist, and so long as things now made endure to be required, the double set of tools must exist, and every one reading an old book will have to translate the figures to comprehend or use the results.

[There is, as usual, much weight in what Prof. Sweet writes, and we doubt very much that any change in our measurements will be made, they being too long established. The suggestions last month were only offered as a substitute for the metric system which some are trying to force on the country, as involving fewer changes and consequently being less objectionable.—ED.]

* * *

THERE is this to be said and it ought to be said, in regard to the engineering and maneuvering ability of those entrusted with the construction and management of the new United States naval vessels. What ought to be said is simply this: With all the education and precedent to work with and from, the results are such as would bring ruin to any large manufacturer of machinery, or steam engines, or the like, in the whole country, or that would put the navigator of an oyster sloop to shame. Vessels for offense and defense that must put ashore for fear that, as a

landsman would put it, they would "tip over," and vessels that go ashore on well known shoals, to say nothing of the damage that results from collision with the commonest kind of a craft, are not reassuring spectacles, but rather ordinary ones.

There seems to be a quarrel between the line and the engineers in our navy, which should be reconciled for the good of the service as well as the pocket-books of the tax-payers. But with all of precedent and all of practice directly at hand, it strikes the average mind as rather peculiar that nothing is really known about withstanding the seas, as old as creation; this, as well as that men should be entrusted with the navigation of the costliest vessels who do not know whether they are running with thirty feet or thirty fathoms of water under the keel.

* * *

YORKSHIRE TOOLS.

JAMES VOSE.

Yorkshire tools have a distinct place in the internal economy of English engineering, and perhaps some description of them will be of interest to American mechanics. The reputation of some classes of Yorkshire tools is rather unenviable, though some of the people who ostensibly disparage them, will often be found buying and using them. The reason for this slighting attitude on the part of other tool-makers and users is—that low-priced tools form the staple product of the greater number of Yorkshire tool-makers, though really high class tools are made by a few firms principally in Leeds. The low priced tools, however, are of great service to users who have but comparatively little use for them, such as mill repair shops, jobbing shops, etc., where days or even weeks, might elapse without the tools being needed. These conditions apply also to colonial requirements, where the mechanics who use them are, by the exigencies of their employment, of a more rough-and-ready type than highly organized concerns would deem suitable for their requirements. Not only this, but even in shops turning out machinery, etc., of good, (and where requiring it) accurate finish, there are often many jobs which do not call for an accurate tool at all, on which to do them, and therefore the low-priced tool is "as good as the best" for the purpose. Though low-priced, it is only simple justice to say that in most instances, they are very good value indeed for the price paid for them, as by the laws of chance a certain proportion of them come out really accurate, and many which have come under my observation are really handier in essentials for easy working and of greater capacity in some respects than the ordinary tool of accurate and conventional build and finish. It often puzzles tool-makers of, say—the Manchester type, how tools can be produced at all, at the prices quoted by many Yorkshire makers; indeed, one Manchester maker always jocularly stated it was his belief that the Yorkshire men stole their castings for a tool, so that they only expended on the finishing of the castings. So far as I have seen or heard of, there are no tools of American make which are purposely built as a low-price tool; so, it appears to me that the Americans must supply the demand by selling second-hand tools which are being discarded by progressive firms. Personally, I should like to know what is done in this matter in America. Quite a number of causes seem to combine to make the production of such low-priced tools as the Yorkshire ones, possible. Firstly, wages are lower than in the Lancashire tool-making centres. Then often it would appear that certain Yorkshire establishments (which make patterns only), let out on hire their patterns to anyone who wishes, so that a dozen small makers may be constantly using the same patterns. Thus the percentage of cost of patterns to each tool-maker is very small. In fact, it almost seems in Halifax, Sowerby Bridge, Keighley and several other towns, that certain foundries keep stocks of tool castings, like iron-mongers keeping a stock of nails or screws, and anyone who can command the use of a few tools, buys a set, and perhaps never has orders for more than one or two tools at a time. On this system, of course, though a person may not make much money, neither need he lose much. These facilities cause, perhaps, a greater number of small shops to be at work in Yorkshire than most districts. Then, again, everything from the very beginning has been studied with a view to a low selling price. Very little is spent on designing tools, owing to the cost being distributed over a number of shops. This fact is shown also by the uncouth shapes of brackets, pulley arms, hangers, etc., and the number of sharp corners generally, where graceful curves might just as well be present. The "leading screws" are often provided with *cast* nuts (in halves) for working the carriage. The use of mild steel is very limited. Common iron set screws are used, and every wheel and rack tooth is *cast*. This last statement will seem like a relic of the dark ages to many American mechanics. Very little beyond planing is done to the sliding surfaces; sometimes a mock scraping is put on, and at other times a fine file is run over them. The cost of office work is often almost nil in many shops, as (and this is possibly one main reason of low-priced production) most of the clerical and executive business is done by the proprietor and his family; and the proprietor is quite satisfied with a percentage of profit which would not be considered worth working for in some districts. It will be found in most Yorkshire towns that trade unions are comparatively weak, and that wages in the engineering trades bear an exact relation to the strength of the trades unions. Readers may form any conclusions they like from the last statement. Some firms in Yorkshire are not averse to making any alteration a custower may desire; so that the tools may often be found with practically all modern features, but very crudely carried out. To sum up, it may be said that the Yorkshire tools may be used to great advantage under certain conditions, and to an extent which will vary correspondingly to the class of work principally turned out in the shop, and to the general standard of taste which the management consider advisable to encourage. In a general way, perhaps, they had better be used too sparingly rather than too freely, as even their best friends never allow them to pose as examples of what tools ought to be.

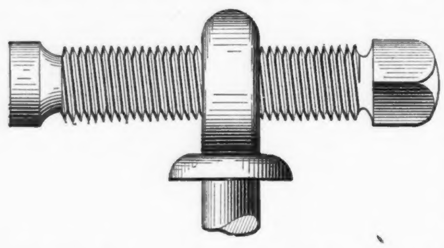
* * *

TRICKS OF THE TRADE.

R. E. MARKS.

It may not sound very mechanical to talk about fixing a spring bed, but the writer was engaged in this meek and lowly occupation when one of the most bare-faced tricks of the trade of spring bed making was disclosed to view, and I was pained beyond expression at finding it, because I had been sold and had been working hard to unscrew a solid piece of cast iron.

We had just moved, and the architect who planned the third story stairs was either accustomed to rubber furniture or else slept on the floor, for the head-board of the bed had to be dismantled, and the spring bed taken apart before a place could be provided for the "pride of the kitchen" to sleep. Then came the tug-of-war to get it together again. I arranged toggles and compound levers enough to move a mountain before I could stretch the springs enough to get them in place and then I wanted to adjust them by the adjusting screw. I noticed that the threads were not very sharp, but thought little of that and tried to turn the screw with a wrench. Then I put a little kerosene around the thread near the nut to cut the gum and left it over night. No improvement; then I got a lamp to look closely at it and I'll be jiggered if the whole piece wasn't a solid casting.



I suppose I'm not the only one who has been sold on this scheme, but it's ahead of anything I've seen lately in the way of a fake.

* * *

A METHOD OF BLACKENING STEEL WATCH CASES.

While the following, taken from *The American Jeweler*, refers only to watch cases, it may be of use to those who wish to blacken other articles of steel:—

After the case has been taken apart, the backs, center, etc., are ground with some abrasive until they present a uniform white appearance, after which they are supplied with suitable holders. A board must also be provided upon which they can conveniently be placed. The pieces are next to be heated (every one to be treated separately) until the color changes from light blue to a whitish grey, when a light coating of linseed oil is applied and quickly burnt off; it can also be brushed, or by striking the article with the brush, then continue the heating and the brushing until the piece presents a fine black surface. This also appears to take place during the evaporation of the oil on the application of heat.

THE DRAFTING OF CAMS—I.

LOUIS ROUILLION.

A cam is a device for converting circular into reciprocating motion. It generally consists of a disc having an irregular face that acts as driver to a follower in contact with it, or else of a groove cut in a flat or curved surface. Cams are very useful adjuncts to many forms of machines, as by their aid various complex and complicated movements may be obtained that were otherwise impossible. Their use is, however, attended with some objections of a character serious enough to warrant the substitution of some other method of arriving at a desired result when such other method is available. Among these objections may be mentioned the considerable amount of friction, producing wear and the noisy action of cam movements. Despite these objections, cams have a wide use and are employed in many familiar machines. Harvesters, printing presses, sewing machines, looms and steam-valve mechanisms are a few of such machines to which cams contribute part of the action. The more complicated forms of automatic machinery depend largely upon the aid of cams. The various machines used in the manufacture of shoes are good examples of this class.

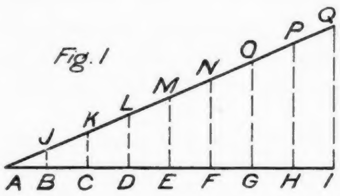


Fig. 1

The process of laying out cams is simple and easily acquired. The laying-out of a heart-shaped cam will serve as an illustration of the general method. This cam is used to convert circular motion into uniform reciprocating motion. Let it be required to lay out a cam that will move a follower with uniform velocity through a throw of $1\frac{1}{2}$ inches. This action may be graphically shown by the aid of a diagram, Fig. 1. The action of but one-half the complete movement need be considered, as the return of the follower, is along a curve similar to that occasioning the rise. Therefore let A I, a line of indefinite length, represent one-half a revolution of the cam. At I draw the perpendicular I Q equal to the extreme throw, in this case $1\frac{1}{2}$ inches. As the rise of the follower is to be uniform, this action may be shown by a straight line connecting A and Q. Divide the line A I into any number of equal parts, say eight, and erect perpendiculars at the points of division. The point E will then represent one-quarter revolution of the cam, and the distance E M will represent the throw at that point. In the same way the distance C K represents the amount of throw at one-eighth revolution, the distance G O the throw at three-eighths revolution, and so on for the other perpendiculars.

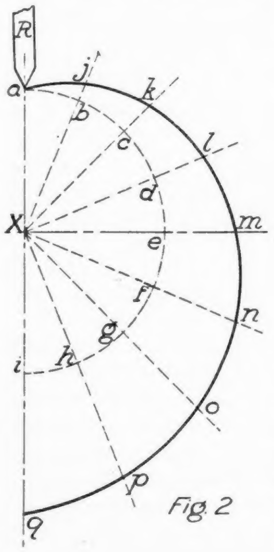


Fig. 2

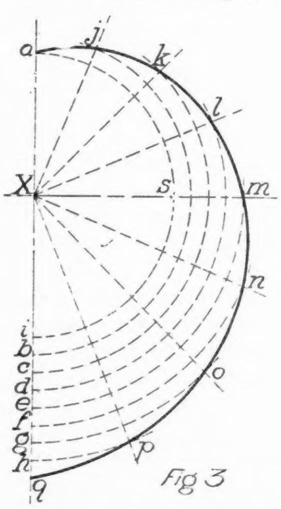


Fig. 3

To lay out the cam curve, describe about X, Fig. 2, as center, any semi-circle *a e i*. Divide this semi-circle into the same number of equal parts into which the line A I was divided. Connect these points of division with the center X and extend the lines indefinitely beyond the semi-circle. On X *b* take *b j* equal to B J, on X *c* take *c k* equal to C K, and so on, extending each radius a distance equal to the corresponding perpendicular of Fig. 1. Then through the points *a*, *j*, *k*, *l*, etc., draw a smooth curve. This curve is one-half the required cam curve. By drawing a similar curve to the left of *a* the cam curve is completed. By rotating the cam about the center, X, the follower, R, would be forced to rise, with uniform velocity, through a distance of $1\frac{1}{2}$ inches. During the second half of the revolution it would fall uniformly, by aid of gravity or a spring, to the initial point *a*.

Another way of laying out the same cam curve is as follows: Draw any semi-circle, *a s i*, Fig. 3, and extend the diameter on one side a distance, *i q*, equal to the required throw. Divide *i q* into any number of equal parts, as at *b*, *c*, *d*, etc., and divide the semi-circle by the same number of radii equally distributed. With X as center and radius equal to X *b* describe an arc cutting X *j* at *j*. With the same center and radius equal to X *c* describe an arc cutting X *k* at *k*. Continue this process through the points *d*, *e*, *f*, etc., thus obtaining the points *l*, *m*, *n*. etc. The latter are points on the required curve.

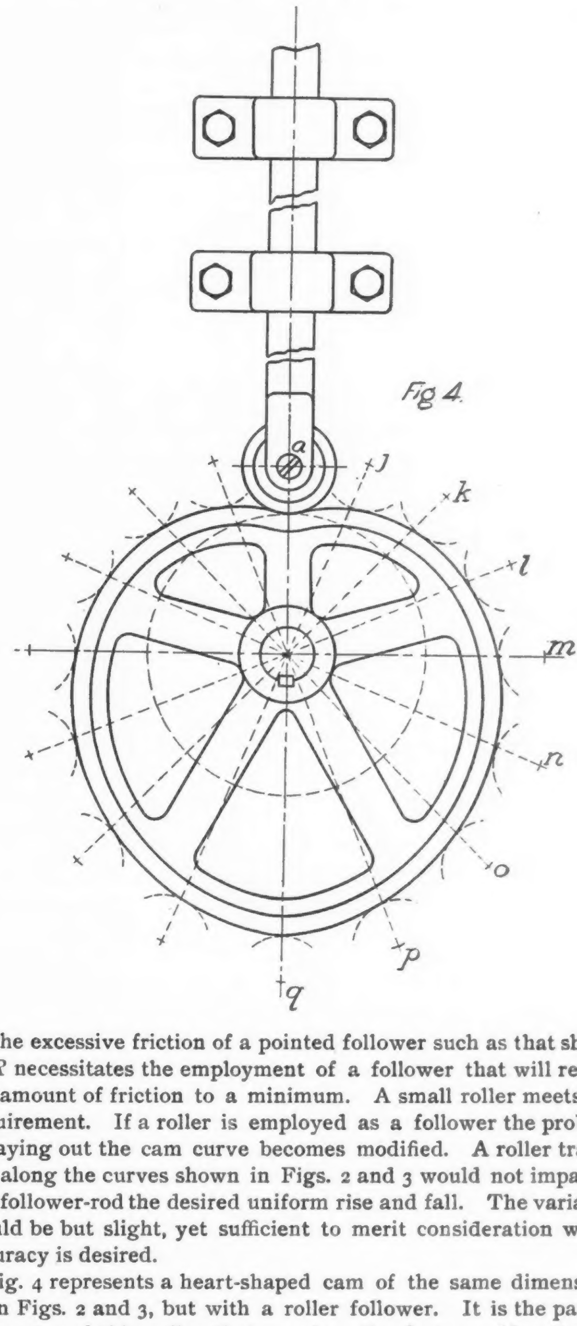


Fig 4.

The excessive friction of a pointed follower such as that shown at *R* necessitates the employment of a follower that will reduce the amount of friction to a minimum. A small roller meets this requirement. If a roller is employed as a follower the problem of laying out the cam curve becomes modified. A roller traveling along the curves shown in Figs. 2 and 3 would not impart to the follower-rod the desired uniform rise and fall. The variation would be but slight, yet sufficient to merit consideration where accuracy is desired.

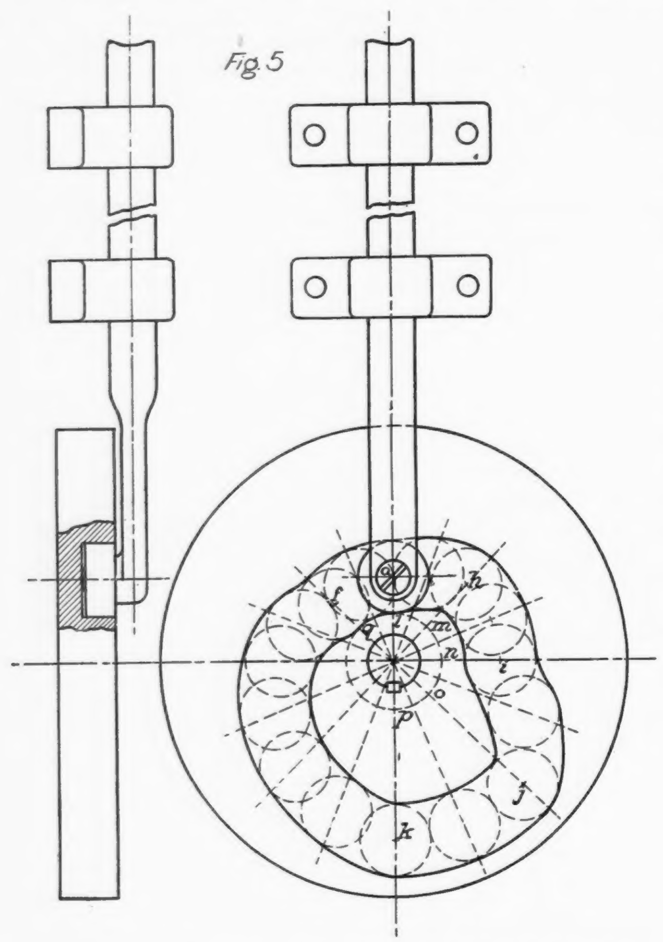
Fig. 4 represents a heart-shaped cam of the same dimensions as in Figs. 2 and 3, but with a roller follower. It is the path of the center of this roller that requires the first consideration, as the position of this center regulates the throw. Therefore the position of the center of the roller at various intervals in the rotation of the cam must be determined. This may be done by adding to each of the distances J B, K C, L D, etc., of Fig. 1, the radius of the roller, and thus obtaining the points *a*, *j*, *k*, *l*, etc. With these points as centers and with radii equal to that of the roller, describe arcs. A curve drawn tangent to these arcs is the required cam curve.

This cam depends upon the action of gravity, or a spring, to keep the follower in contact with the driver. It can be made positive in action by the use of two followers placed at the extremities of the diameter of the cam, or by drawing curves tangent to both the top and bottom of the follower in its various

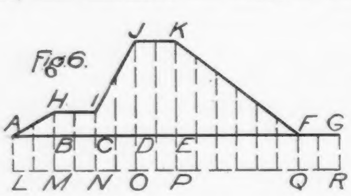
assumed positions, and the two curves taken as the boundaries of a groove cut into the metal.

A familiar application of the use of a heart-shaped cam may be found in the bobbin-winder of the Domestic sewing machine. The thread is fed to and fro at a uniform rate, the follower of the cam acting as a guide for the thread. The action is made positive by the employment of two follower-rollers.

The latter method of laying out a positive motion cam referred to above is more clearly shown in Fig. 5. A variable motion is



here substituted for the regular motion of the heart-shaped cam. Let it be required to lay out a positive motion cam that shall impart to the follower the following action: A uniform rise of ¼ inch during the first eighth of a revolution; no action during the next eighth; a uniform rise of ¾ inches during the third eighth; no action during the fourth eighth; a uniform fall of 1 inch during the next three eighths of the revolution, and no action during the last eighth. The action is graphically shown in Fig. 6. Let A G represent one complete revolution of the cam; B the first eighth, C the second, D the third, E the fourth, and F the seventh. The problem calls for a uniform rise of ¼ inch during the first eighth. Therefore from B draw the perpendicular B H, ¼ inch in length, and join A and H. As there is to be no action during the second eighth, draw H I parallel to B C; that is, the follower will be the same distance from A G at I that it was at H, and therefore the follower will not have been acted upon. During the next eighth revolution the follower is required to move ¾ inches. As it has already moved ¼ inch, the sum of these two distances is the length D J. As this rise is to be uniform, a straight line is drawn joining I and J. No action during the fourth eighth is shown by drawing J K parallel to D E. A uniform fall of 1 inch during the next three-eighths of the revolution is shown by joining K and F, and the period of rest during the last eighth revolution is shown at F G. The line A L is equal to the radius of the roller, and by drawing the line I R parallel to A G, the distance of the center of the roller from the base circle may be taken directly upon any radius of the cam.



To lay out the cam from the diagram, draw any base circle $l\ n\ p$, Fig. 5, and divide it into the same number of equal parts into which the line A G is divided, viz., sixteen. Through these points of division draw radii and extend them indefinitely. Upon these radii take $l\ a$ = L A, $m\ h$ = M H, $n\ i$ = N I, etc., thus determining the positions of the center of the roller at the various intervals. Sketch in the outline of the roller in its different positions and draw curves tangent to these outlines.

* * *

STRENGTH OF THICK, HOLLOW CYLINDERS.—1

John H. Cooper.

Rules for thin and thick walled hollow cylinders for sustaining internal pressure are many and various.

For thin cylinders, the rules given by all authorities are the same in every particular, because they regard the materials of the cylinders as having uniform texture and every part of the same as being under equal tension, which means that the net areas of their sections may be taken as the measure of their strength.

This measure will not apply to thick cylinders, as will appear later on, and for which some reasons will be given, experience proving that increased thickness does not add proportional increased strength.

The rules which provide for this anomalous condition of the material, due to its position, are based upon the general formula for the strength of hollow cylinders to which additional thickness is given, and the amount of this is found to vary greatly by the dictum of different authorities.

Some rules show great ingenuity of method. For some it is difficult to see how algebraic expression, merely, can give strength, which resides only in the material, and as for this, tests can apply only to the samples of material tested. There is no one rule applicable to all, and for imperfect material there is no rule whatever.

In what follows will be found the work and results of many well known writers. These are placed for easy comparison with worked-out examples. Many rules show only half truths, and therefore, do not apply, and many lead to no tangible results in the line of our enquiry; they are, therefore, "better missed than found."

Our work here is chiefly to exhibit the practical quality of a thing, which is necessary to have and to know, if work is to be done; also to furnish the data of actual performance, which points out the shortest road to successful use.

First, let us consider the cross-section of a thick, hollow cylinder, which we will suppose divided into concentric rings, fitting closely together, and that each and all of these rings have a certain and equal amount of elasticity per unit of length or circumference. "Then, supposing a certain uniform pressure to be exerted all around the interior boundry of the inner ring, it will readily appear that each successive circular ring—counting from the inner one to the outer one—offers a less and less resistance to the internal straining force. This is manifest, "for a resistance which any solid body offers to the force by which it is strained is proportional to the extension which it undergoes, divided by its length."

Under this condition of things the inner rings will be subjected to strains beyond their elastic limit, before the outer rings take their share of the pressure; in consequence of this, the inner rings may suffer rupture before the outer rings come to full bearing, since their capability of extension, because of their greater length, is much greater than the inner rings. In other words, the elastic limit of the outer rings is not reached until after the inner rings have failed, whence, in an instant, all fail and a sudden burst is the result.

The explanation exhibits the elements of this complex problem, for the study of the effect of internal pressure upon thick walled, hollow cylinders, is not a simple matter.

Let us now make and present a judicious selection of published rules, with formulæ and remarks thereon:

In Gregory's *Mathematics for Practical Men*, Royal Military Academy, Woolwich, 1825 and reprint of same, 1833, page 289, is quoted Mr. Barlow's rule:—

$$t = \frac{p\,r}{c - p}$$ in which t = thickness in inches; p = hydraulic pressure in pounds per square inch; r = internal radius; c = cohesive strength of the material in pounds per square inch, and then he gives two worked-out examples by way of explanation.

thus: "Let it be desired to find the thickness of metal in each of two cylinders having 12-inch bore, to just sustain an internal pressure of 1½ tons per circular inch for one of them, and 3 tons per circular inch for the other, the ultimate cohesion of cast-iron being 18 000 lbs. per square inch.

Now, 1½ tons per circular inch = 4728 lbs. per square inch and 3 tons per circular inch = 8556 lbs. per square inch. Whence by the rule we have,

$$\frac{4278 \times 6}{18000 - 4278} = 1.87'' \qquad \frac{8556 \times 6}{18000 - 8556} = 5.44''$$

Whereas, on the usual principle of computation (using the rule for thin cylinders), the latter thickness would be exactly double the former; extensive experiments are necessary to tell which method deserves the preference."

Turnbull, in 1831, quotes Barlow's rule from Gregory. To obtain a result, let us introduce the figures of an actual case, say, 8 inches radius of interior; 6000 lbs. per square inch hydraulic pressure and 18 000 lbs. per square inch U. T. S. of the cast-iron used for the cylinder; then, inserting these figures in this formula, we will have

$$t = \frac{6000 \times 8}{18000 - 6000} = 4 \text{ inches.}$$

Referring again to Mr. Barlow's original paper on "The resisting power of the cylinder and rules for computing the thickness of metal for presses of various powers and dimensions," published in *Trans. of the Inst. of C. E., Vol. I., London, 1836*, and passing over his "investigation of the nature of the resistance opposed by any given thickness of metal in the cylinder or ring," we give his conclusion and application in his own words and formula:

"Let r be the radius of the proposed cylinder; p the pressure per square inch on the fluid, and x the required thickness; let, also, c represent the cohesive strength of a square inch of the metal. Then, the whole strain due to the interior pressure will be expressed by px, and that the greatest resistance to which the cylinder can be safely opposed is: $c \times \frac{rx}{r+x}$; hence when the strain and resistance are in equilibrium, we shall have,

$$rp = \frac{rx}{r+x} \times c, \text{ or } pr + px = cx:$$

$$\text{Whence } x = \frac{pr}{c-p} = \text{the thickness sought.}$$

"Hence, the following rule in words, for computing the thickness of metal in all cases, viz., multiply the pressure per square inch by the radius of the cylinder, and divide the product by the difference between the cohesive strength of a square inch of the metal and the pressure per square inch, and the quotient will be the thickness required."

Applying this rule to our case, we will have:

$$x = \frac{6000 \times 8}{18000 - 6000} = \frac{48000}{12000} = 4''.$$

Mr. Barlow says: "We may, without sensible error, call the cohesive power of cast-iron 18 000 lbs. per square inch. It will, of course, be understood that the thickness found by this rule is the least that will bear the required pressure, and that, in common practice, presses ought not to be warranted to bear above *one-third* the pressure given, unless it should appear that the estimated cohesive power of cast-iron is too little; if this actually exceeds 18 000 lbs., a corresponding reduction may be made in the computed thickness."

In the beginning of his article, Mr. Barlow says: "I am not aware that any of our writers on mechanics have investigated the nature and amount of the circumferential strain which is exerted in a hydraulic cylinder by a given pressure on the fluid within." So we have in this article, presumably, the first investigation and rule upon this subject. Mr. Barlow further says: "It would appear at first sight, that, having found the strain (at the two sides imposed by the pressure of the fluid within), it would only be necessary to ascertain the thickness of metal necessary to resist this strain when applied directly to its length; this, however, is by no means the case, for if we imagine, as we must do, that the iron, in consequence of the internal pressure, suffers a certain degree of extension, we shall find that the external circumference participates much less in this extension than the interior, and as the resistance is proportional to the extension divided by the length, it follows that the external circumference and every successive layers, from the interior to the exterior surface, offers a less and less resistance to the interior strain."

The above statements prove that Mr. Barlow recognizes the existence of variable strains upon the mass of the cylinder's walls during pressure, and states clearly that they decrease from the inner to the outer surface.

Mr. Barlow states distinctly the importance of knowing definitely, the cohesive strength of the metal, and that whatever it is, it must so take its place in the formula. He does not state, however, nor caution the maker of press cylinders against the danger of the weakening effect due to the unequal shrinkage in the walls of the cylinder, while the same are cooling after being cast. That such action does take place is a matter of common observation, and yet there seems to be great difference of result, as proven by test, about this phenomenon of cooling. We may quote such high authority as Mr. Hodgkinson, who says: "Comparing the tensile strength of bars of cast iron 1, 2 and 3 inches square, I found that the relative strengths were approximately as 100, 80 and 77." Capt. James gives 100, 66 and 60 for similar bars, and that ¾-inch square bars, cut from 2 and 3 inch bars, possessed only half the strength of 1-inch square cast bars. The cause of this being attributed to the greater strength of the "skin" portions of castings and to the more spongy and therefore weaker texture of the interior, which increases with the thickness.

In opposition to these statements let me add, here, that test pieces have been taken from the walls of certain 5-inch thick cylinders of American cast iron which exhibited in every part an equality of tensile strength, thus showing the uniformity of texture throughout the mass, not only by observation but by the ordeal of experiment. I may add that the texture of the material in the 8-inch cylinder walls—noted above and below—and which failed, was, to all appearances, sound and solid, through and through, at the ruptured sections. Another feature of cast-iron must be observed; there is little or no indication of an ascertainable and measurable elastic limit.

"*Ordinance Notes*" say: "Cast-iron rarely shows a well defined limit of elasticity. The elastic limit to extension is 15 000 lbs. per square inch."

We know too well by experience, and we therefore quote the words of Mr. H. T. Bovey, in his work on the "*Strength of Materials, 1893*, that *cast-iron* is, perhaps, the most doubtful of all materials, and therefore the greatest care should be observed in its employment. It possesses little tenacity, or elasticity; is very hard and brittle and may fail suddenly under shock, or under an extreme variation of temperature.

"Unequal cooling may pre-dispose the metal to rupture, and its strength may be still further diminished by the presence of air-holes. Cast-iron and similar materials receive a sensible set, even under a small load, and the set increases with the load."

We certainly know that all experience proves the need of intelligence and care in the proportioning and making of cast-iron hydraulic press cylinders.

As to the choice of material, not including the steels, Rankine gives the U. T. S. of cast-iron: 13 400 to 29 000 lbs. per square inch, which assures undoubted evidence of the possibilities of this metal. High tensile strength, however, must not be the ruling element in the choice of metal for such castings as are liable to be affected by shrinkage strains. For example, of the effects of sudden cooling, we may refer to those well-known toys, called Prince Rupert's drops, which possess the infirmity of superficial tightness, combined with uncertain interior, and which are found to have no more strength than that given by their skins,

"Whose least part touched the whole doth fly,
And philosophers are puzzled to find out, why."

The case in practice to which reference is made, is one that came under the care and construction of the writer in the year 1874. Several presses were ordered to have 15-inch diameter of rams, with cylinders to sustain 6000 lbs. per square inch of hydraulic pressure. By what rule these presses were proportioned is lost to memory, but the interior diameter for ram clearance was made 16 inches and the walls were 8 inches thick: *i. e.* same as internal radius. The first one was cast from an air furnace of hard, close texture cast-iron, such as rolling-mill rolls are made

of; this one burst at the first trial. Another was ordered, of same dimensions, to take its place, but to be made of soft and tough iron. This one stood the test, is in use to-day and is frequently put under a hydraulic pressure of 4 tons, or 8000 lbs. per square inch.

Referring now to some of the published rules, the following notation is made uniform for the first five formulæ.

Let P = Internal pressure in lbs. per square inch.
S = Tensile stress in lbs. per square inch to which the material is subjected by the pressure P.
D = Internal diameter of the cylinder in inches.
t = Thickness of metal in inches.
e = Base of Napierian system of Logarithums = 2.71828.

The ultimate tensile strength of cast-iron is taken at 18 000 lbs. per square inch; the internal hydraulic pressure at 6000 lbs. per square inch, and the internal diameter 16 inches. The worked-out result is given with each formula.

Bernoulli, Unwin, Rankine, Claudel, Weisbach, Van Buren, Haswell, Lanza and Clark, give this first formula for ascertaining the thickness of *thin* cylinders, without joint:

$$\text{1st.}\quad t = \frac{D}{2}\ \frac{P}{S} \quad \text{or} \quad t = \frac{P\,r}{S} = 2\tfrac{2}{3} \text{ inches,}$$

in which r = radius or half of D.

Reuleaux gives for thick cylinders:

$$\text{2d.}\quad t = \frac{D}{2}\ \frac{P}{S}\left\{1 + \frac{P}{2S}\right\} = 3.1 \text{ inches.}$$

Trautwine repeats the same, but adds a factor of safely k, which we will assume to be 3, thus:

$$\text{3d.}\quad t = \frac{D}{2}\ \frac{Pk}{S}\left\{1 + \frac{Pk}{2S}\right\} = 12 \text{ inches.}$$

Omitting k we will get $t = 3.1$ same as by Reuleaux's rule.

Brix and Clark give:

$$\text{4th.}\quad t = \frac{D}{2}\left\{e^{\frac{P}{S}} - 1\right\} = 3.16 \text{ inches.}$$

Grashof gives:

$$\text{5th.}\quad t = \frac{D}{2}\left\{-1 + \sqrt{\frac{3S + 2P}{3S - 4P}}\right\} = 3.84 \text{ inches.}$$

Prof. Merriman's formula for the thickness of *thin* cylinders to resist internal pressure, may be derived from his general formula, thus:

$p\,d = 2\,t\,S$, in which,
p = pressure per square inch of the liquid within the cylinder in lbs.
d = internal diameter of the cylinder in inches.
t = thickness of the walls of the cylinder in inches.
S = Working tensional stress of the material in lbs.

By transposition we get: $2\,t = \frac{p\,d}{S}$ By substituting the radius for the diameter, which simplifies the formula, we get: $t = \frac{p\,r}{S}$, and then by solving the problem of our data, although this formula is not intended for application to thick cylinders, yet we work it out for the sake of comparison with others. We have, then:

$$t = \frac{6000 \times 8}{18000} = 2\tfrac{2}{3} \text{ inches,}$$

which is the same result as given by the first formula. This rule is in harmony also, with the formula used by all boiler inspection companies for the thickness of boiler plates. Prof. Merriman further says: "For very thick cylinders this formula is only approximative."

* * *

In the notice to machinists and tool-makers on page 196 of the February issue, the name of John M. Rogers, Boat, Gauge & Drill Works, was erroneously substituted for that of the Arcade File Works, thereby causing considerable inconvenience to the former firm as well as to our readers, which we regret. Any one wishing to obtain a standard technical work at very little trouble to themselves and at no expense, should write the Arcade File Works, 97 Chambers St., New York City, and their enquiry will receive immediate attention.

MECHANISM FOR MECHANICS.—2.

Prof. Chas. H. Benjamin.

In figure 3 let Ba represent the velocity of the current and Bb the velocity of rowing. Draw bc parallel to Ba and ac parallel to Bb until they intersect at c. Then will Bc represent the resultant velocity of the boat. This example shows in what direction and how fast the man must row in order to send the boat straight across the stream.

In general, if we represent the component velocities of a moving body by two straight lines as Ba and Bb, the resultant or whole velocity will be represented by the diagonal Bc of a parallelogram constructed with the component lines as sides.

COMPONENT VELOCITIES.

Having the real velocity of a moving piece given, we can work backwards and find the component velocities in any desired direction.

In figure 4 the crank C, turning in the direction of the arrow, pulls the bar B horizontally by means of the slotted cross-head H. The line Pc drawn perpendicular to the radius CP will represent the velocity of the pin P at this instant. Draw the horizontal line Pa and the vertical line Pb, and from c draw the perpendiculars ca and cb.

Then Pa will represent the velocity with which the bar will move horizontally, while Pb will represent the velocity of sliding of the pin in the slot. The motion of the pin is thus mechanically resolved into two other motions at right angles to each other, and the figure shows the relative values of the different velocities.

In figure 5, let the radius of the crank be $CP = r$. Let the velocity of the pin be $Pc = v$ and let the angle $PCD = x$.

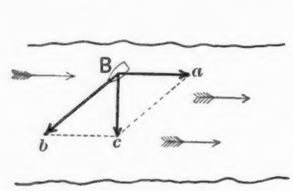


Fig. 3

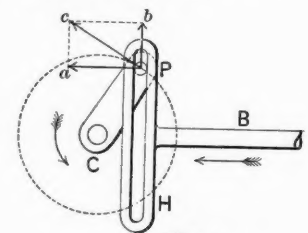


Fig. 4

Let the horizontal component of v be $Pa = v^1$ and the vertical component be $Pb = v^{11}$.

$$\text{Then:}\quad \frac{v^1}{v} = \frac{Pa}{Pc} \quad \text{or} \quad v^1 = \frac{Pa}{Pc}\,v$$

$$\text{and}\quad \frac{v^{11}}{v} = \frac{Pb}{Pc} \quad \text{or} \quad v^{11} = \frac{Pb}{Pc}\,v$$

But the triangle PCD is similar to the triangles Pca and Pcb, therefore,

$$\frac{Pa}{Pc} = \frac{DP}{CP} \quad \text{and} \quad \frac{Pb}{Pc} = \frac{CD}{CP}$$

Substituting these values, we have:

$$v^1 = \frac{DP}{CP}\,v \quad \text{- - - - - - - - - - - - - - -} \quad (3)$$

$$v^{11} = \frac{CD}{CP}\,v \quad \text{- - - - - - - - - - - - - - -} \quad (4)$$

By trigonometry the expressions $\frac{DP}{CP}$ and $\frac{CD}{DP}$ are called respectively the sine and cosine of the angle x, and values of these for different angles may be found in any table of sines and cosines.

Finally then, we have:

$$v^1 = v \sin x \quad \text{- - - - - - - - - - - - - -} \quad (5)$$

$$v^{11} = v \cos x \quad \text{- - - - - - - - - - - - -} \quad (6)$$

and this means that when a crank pin drives a slotted cross-head as in figure 4, the velocity of the cross-head at any instant is equal to the velocity of the pin multiplied by the sine of the crank angle, and that the velocity of sliding of the pin in the slot is equal to the velocity of the pin multiplied by the cosine of the crank angle.

Example 2. Let the crank radius CP in figure 5 = $2\tfrac{1}{2}$ feet, and let the crank make 75 revolutions per minute. To find the velocities of the cross-head and of the sliding of pin in slot when the crank has turned 60 degrees from the dead point at A.

$v = 2\pi Nr$ See equation (2).
$= 6.283 \times 75 \times 2\frac{1}{2}$
$=$ 1178 feet per minute.

By consulting a table of sines, we find that the sine of 60 degrees is 0.866 and the cosine is 0.5.

Therefore, the velocity of the cross-head is: $v^1 = 1178 \times .866 = 1020$ feet per minute, and the velocity of sliding of the pin in the slot is: $v^{11} = 1178 \times .5 = 589$ feet per minute. If no table of sines is at hand, the figure may be drawn carefully to scale and the values of the ratios $\frac{DP}{CP}$ and $\frac{CD}{CP}$ obtained by measurement.

CRANK AND CONNECTING-ROD.

The combination explained in the preceding paragraphs is not generally used on account of the large amount of friction, caused by the sliding of the pin in the slot.

The crank and connecting-rod, as commonly used on the steam engine, give nearly the same motion to the cross-head and are much more efficient. The velocity of the cross-head, when the connecting-rod is used, may be most easily determined graphically by the use of what is called the instantaneous center.

In figure 6, let v represent the velocity of the pin P at any instant and v^1 the corresponding velocity of the cross-head B. Then, if we consider the rod PB, it may be regarded as revolving about the point I; for as the end P is moving in the direction Pv it has the same velocity as if it were turning about a center anywhere in the indefinite line CPI. For the same reason B may be regarded as turning for the instant about any center in the perpendicular BI.

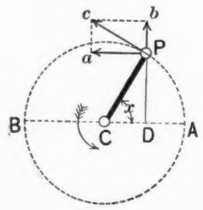


Fig. 5

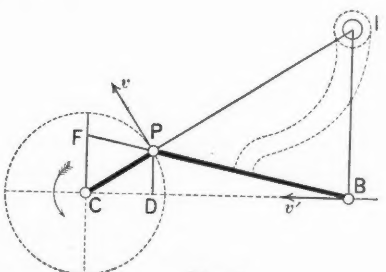


Fig. 6

As the point I is the only point common to both lines, it is the only center which will answer for both points P and B. If we should connect the rod PB to the center I, as shown in dotted lines, and turn it about I, the motion at this instant would be precisely the same as its real motion.

In general, the instantaneous center of a piece moving in one plane can be found at the intersection of two perpendiculars drawn from two points in the piece at right angles to the motions of those points. It is only an *instantaneous* center and changes its position constantly.

Now, it has already been shown that the velocities of points in a turning piece vary, as their distances from the center. The velocity of B in figure 6 will then be just as much less than the velocity of P as BI is less than PI or in symbols $\frac{v^1}{v} = \frac{BI}{PI}$

Produce the line of the rod PB until it intersects the perpendicular through C at F. Then the triangle FPC is similar to the triangle BPI, as their sides are respectively parallel

$$\text{Accordingly, } \frac{CF}{CP} = \frac{BI}{PI}$$

$$\text{and therefore, } \frac{v^1}{v} = \frac{CF}{CP} \text{ - - - - - - - - - - - } (7)$$

This latter construction makes it unnecessary to find the instantaneous center.

Example 3. Use the same values as in Example 2, save that a connecting-rod, 10 feet long, is to take the place of the slotted cross-head. To find the velocity of B. As before, $v = 1178$ feet per minute; angle $PCD = x = 60°$.

Drawing the figure carefully to scale we find that $CF = 2.43$ feet, and that $\frac{CF}{CP} = \frac{2.43}{2.50} = .972$

The velocity of the cross-head B at this instant, is therefore: $v^1 = 1178 \times .972 = 1145$ feet per minute instead of 1020 feet, as in Example 2.

We learn from this that the effect of a connecting-rod is to make the velocity of the cross-head greater in this part of the stroke than it would be if a slotted cross-head were used. If the same method were used for angles greater than 90 degrees, we should find the velocity diminished by the use of the rod, instead of increased. This difference is due to the angularity of the rod; is measured in the figure by the difference in length between CF and PD, and becomes greater as the rod used is made shorter.

Problem 4. Find the velocity of the cross-head in Examples 2 and 3 when the angle $x = 135$ degrees $= -45$ degrees.

Find by construction when the velocity of the cross-head is greatest, and also when it is equal to that of the pin in figure 6.

* * *

"A ROLLING STONE GATHERS NO MOSS."

BEEN THERE.

I don't like the proverb-crank; he finds a proverb to fit every case, and is governed by the proverb instead of using analysis, mixed with horse sense. I am reminded of this by a *young* man who wants me to help him get a *permanent* position; says he has been "knocking around" for the past two or three years; that "a rolling stone gathers no moss," etc., etc. Now, just because a rolling stone gathers no moss, it does not follow that everything on the face of the earth that could be likened to a rolling stone, would not gather anything that could be likened to moss. I told this young man that the knocking around to which he objects, is the very thing he needs at his age to sharpen his wits and teach him to depend on himself. I do not know of a more pitiable sight than an old man who has always before had a permanent position, looking around after a job. Permanent positions do not always last, to use a Hibernianism, and when they end it is almost always when a man is too old to hustle around for another, even if he wasn't spoiled by having been in one place all his life.

There is no one shop, or office, or man, that knows it all. A young man cannot do better than to get an *experience* while he *is* young, and not the least important is the fact that he makes acquaintances while he is getting his experience. A very ordinary man who has an extensive acquaintance is much better equipped to fight the world than a better man who has always been in one place, and knows no one outside of the place. It is a good thing to have the experience of being "out of a job" while young, because, then, it doesn't crush a man to be out of a job when old, as he has been there before and he has his acquaintance. I do not mean that a man need not be competent if he has the acquaintance, but that, being competent, the acquaintance will help him to a new job when he loses the old one.

The man who has always been in one place is the man who dares not make a move without a precedent; he is the man who says: "What was good enough for my grand-father is good enough for me."

"Knock around" till you have a good experience and acquaintance, and if you lose a "soft thing," call it a special Providence for your future good. While in this period of your career, you will incidentally find out which branch of your business you are best fitted for, and will not (after you have the experience) make the mistake of taking the first position that offers, simply because it is a position, but will wait until the *right position* is open.

If you must be governed by proverbs, here is a sort of one that covers the case: "Don't be tied to *anybody's* apron-strings."

* * *

THE DEMING CO., the well known pump makers of Salem, Ohio, have favored us with one of their little pocket memorandum books, which are as handy as the proverbial pocket in a shirt. It is compact, has a place for entries each day as well as memoranda, together with a page for personal matters. Last but not least, it calls attention to the merits of their products.

* * *

MR. W. H. P. FISHER, so long and favorably known as one of the pioneers of the traveling force of the Hoppes Manufacturing Co., of Springfield, O., has been placed in charge of the Eastern office of this company, which they recently opened at room No. 604 Girard building, Philadelphia.

* * *

MESSRS. GOULD & EBERHARDT, of Newark, N. J., recently ordered 108 subscriptions to MACHINERY to be sent to the house addresses of the machinists in their employ, the bill for which was paid by the firm.

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Fred H. Colvin, Editor.
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Associate Editors.

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WE solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense.

ALL copy must reach us by the 10th of the month preceding publication.

THIS PAPER HAS THE LARGEST CIRCULATION OF ANY PUBLICATION IN THE MACHINERY TRADE.

MARCH, 1897.

CONTENTS:

THEORY AND PRACTICE.

The contentions between theory and practice seem likely never to get nearer a settlement. The mission of the old quarrel is one of harm. One of the worst stumbling blocks to-day in the way of the pushing young mechanic who prides himself on being severely practical, is the loose and unauthorized way in which the very word "theory" is used. Not alone the way in which it is used by plain people who make no pretension to set the pace for the use of terms and language, but by those whose superior education ought to have taught them better. It is safe to say that nine times out of ten where the word is used with reference to mechanical operations, such a meaning is given it, by imputation, and in contradistinction to practice, as the best lexicographers never contemplated. The whole trouble between theory and practice seems to be one of definition. Take what Horace Greeley would have called the true "dictionary meaning" of the word "theory," and then, if possible, imagine such a person as a theoretical machinist, blacksmith, pattern-maker, boiler-maker, moulder, clay-moulder, mechanical engineer, or a doer of anything that is useful, if you can. Authors of books on mechanical subjects, books for common sorts of mortals, might well be at pains to dispel this ever-at-hand bugbear of theory, which in a great many instances hinders the sale of their works. Take the steam engine, for example. There is a large number of books published on this very important machine. All theory, the practical man says. The fact is, if reference be had to any book on the subject worth reading, any book written at this day, there is not enough pure theory about it to fill a page. Theory is never responsible for anything about a steam engine, from a crank-pin to an anchor bolt. Everything from the port area to the size of the foundation is purely a matter of experiment—practice. This without saying a word against theory.

Theory is quite right in its way, but its way is not the building of steam engines, nor engine lathes, nor anything of the sort. Every designer of either of the machines named gets his ideas from the practice of others, either from direct observation or from what is written about that practice. It is not a question with him how a ten inch shaft *ought* to run, according to figures, but a question of how it *does* run according to practice. The facts in relation to this and a hundred other things are gathered, formulated, and put into convenient shape for reference by the book-maker, and that is about all there is of it.

It would be unnecessary to refer to such evident facts were it not for an entirely unwarrantable prejudice against the word "theory" in otherwise well-balanced minds, a prejudice that finds vent in such expressions as "book mechanics," "book engineers," and so on along the line of useful occupations. If there is a thoroughly abused word in the English language that word is "theory." If writers, who make free use of it, would proceed to define it before doing so, they would do the mechanical world a real benefit.

* * *

MAKING AND SELLING.

It would be better for both employer and men if they were more familiar with each other's affairs; for while the former, occasionally risen from the ranks himself, probably knows more of the manufacturing than the employee does of the selling part of the business, a common knowledge of both is often lacking. The price of every commodity, be it a milling machine or a tenpenny nail, must bear a percentage of expense which represents the cost of selling it, whether that selling is done by the manufacturer through his salesmen or by an agent or dealer. If people could or would buy direct from the maker, the cost of selling would be lessened in most cases; although few manufacturers—except those making special machinery, for the sale of which personal communication is necessary—have the means or organization to market their own product direct.

In addition to the cost of selling must be considered the office expense, the interest on investment (often borrowed money), deterioration of plant, experimental work to keep abreast of competition, bad debts which are contracted in spite of every care, catalogues and other advertising necessary to make the product known, and many smaller items which enter into the expense of every business. All these must be provided for before any profit appears. The men too often imagine that the difference between the cost and selling price is clear profit, or nearly so, and the result of this belief is seen in the too frequent failures of co-operative stores and factories, the successful ones having evidently learned to allow for the selling as well as the manufacturing cost.

The effect of this belief is to make the men discontented when they figure out this apparent profit, and the sooner it is thoroughly understood that the cost of selling is frequently more than the cost of making, the sooner some of the friction will be lessened. We do not say that the net profit is always as low as would be considered a fair return for money invested, or that the men always receive a just share of the products of their labor; but we wish to make clear the fact that making and selling are two very different things, in the belief that a clear understanding will be

better for all concerned. The conditions which necessitate such an effort to dispose of manufactured articles, may be at fault, but as they exist we must deal with them as we find them.

* * *

JUST ABOUT JOHNSON.

There isn't any climax to this little narrative of some of Johnson's experience—only the true story and nothing more. You see it's this way: Johnson had mined Surgo's old engines out of six inches of grease and dirt; got it so that it worked more or less like a steam engine; knew which way to start when he pulled her open, and didn't have more than a quarter of an inch of lost motion anywhere, and then quit because Surgo wouldn't consult a boiler maker's interest when the water ran out through a cracked sheet faster than he was reasonably certain of pumping it in. Quit, Johnson did, and went to work the next day with the big compound over at the new mills. Johnson had a job there that makes a man good-natured. Lots to do distributing 700 HP. around the mill, and lots to do it with.

Armstrong—that was the old super's name—didn't know any more about a power plant than a Sioux Indian knows about the ten commandments; but he knew a good deal more than that—he knew he didn't know anything about it. Hired Johnson because he wanted some one who did know, and didn't lose any time in making this plain to him. If Johnson didn't have what he needed to keep things going right it was his own fault. Nice engine, nice room, and all the little belongings that go with a nice plant, Johnson had, and of course the engines went right.

Did you ever notice, Mr. Editor, that when an engine is set amongst good surroundings it seems to get right in sympathy with them. Hard to make such an engine go wrong, kind of seems to be.

Everything went smooth with Johnson as long as Armstrong was around. Johnson knew just what was expected of him, and he was backed up by liberal treatment and all the pride in his responsibilities that was necessary. But just as it happens, when things got settled down running Sunday-fashion like, Armstrong struck a higher job. Quit, Armstrong did, and one of "the family" took his place. Auker was the name of the new superintendent. Now, Auker didn't know so much about Johnson's job as Armstrong did, but he made it all up by what he didn't know; balanced up even-like, just as you have seen such things before, Mr. Editor.

Auker put in lots of time around Johnson's department, and when he instructed Johnson's foreman to fire deeper and carry the water right up to the top of the glass, Johnson kicked. No use talking to Auker. "Didn't stand in along with reason," he said, "that a boiler-maker put in a furnace twenty-four inches deep just for a little fire six inches deep, and Mike soldiering around and throwing on a couple of shovels of coal every fifteen minutes. Ought to fill them furnaces right up full in the morning, then, if I want to send him on an errand for a half hour, fires won't go out before he gets back. Then that water ought to be a foot higher. Suppose the pump and injector should both fail some day; why you want water enough in the boilers to run a half day while you humor them. Seems to me that Mike just fools around them boilers when they ought to take care of themselves most of the time."

If it hadn't been for the Old Man, Johnson would have hunted a new job the next day, but the Old Man wouldn't have it that way. Things went along crooked-like till fall, when one morning the piston-rod let go. Didn't break in the key-way where they say all well regulated rods break, but close up to the high piston. Didn't do any particular damage, but here was Auker's chance to even-up things with Johnson. Couldn't discharge him because the Old Man would object, but the new rules and regulations he'd posted the day before, would fix things. Just pointed to the side of the room, Auker did, that was fairly well covered with one of the new posters, and said:

"I suppose, Mr. Johnson, you have read my new rules and regulations?"

Johnson allowed that he hadn't had time to do them justice, not yet.

"Your own fault, then. I saw to a copy being posted right before you. These rules and regulations are just what these mills are run by, and they say, right here, that if any part of the machinery comes to injury through the negligence of an employee, that employee will be held responsible for all damages." (Through the negligence, mind you). "Now, you are hired to keep that engine going whenever I want it to go; and you sit down at that desk and fool away your time over marks on pieces on paper; marks that don't amount to anything, and let that engine go right to pieces under your own shadow. That's what I call negligence of the broadest kind, and you'll pay for every dollar of repairs. That's plain enough I should hope."

Johnson intimated that he was rather busy clearing away the wreck and didn't have time to discuss the question of paying for repairs, then. Auker started for the Old Man's office; got there just as the Old Man did.

"Well," said he, "Johnson has wrecked the engine; just wrecked it, sure. Broke a piston-rod right in two pieces; right in two pieces, sir, and when I began to talk with him about it—told me he didn't have time to discuss the matter; too busy clearing away the wreck and getting ready to run again. Run again; why, sir, that break will keep the mills idle for two weeks—two weeks and not a day less, and all from Johnson's negligence. But we've the best of him by one day. Here's a copy of my new rules and regulations I had posted yesterday morning. Just yesterday morning, sir," said Auker, triumphantly. "Rather thought Mr. Johnson would run right up against this clause about damage to machinery. Came rather sooner than I expected, but I knew it had to come." The Old Man read the clause that Auker pointed out, two or three times, then he glanced along down reading, once in a while, a clause, then:

"So you have taken down the old notices and put these up?"

Auker admitted with evident pride that that was what he had done. "I spent two months over those rules and regulations before they suited me; had two sets printed before I got them to suit me, but now I couldn't change a word if I worked over them a year."

The Old Man was a little puzzled, finally he said: "You have got a lot of rules and and regulations here as long as your Dutch search warrants. I don't suppose anyone would read them all through, and if he did, would never understand them. "Here," fishing one from his desk, "is all that Armstrong ever found necessary. It don't take long to read what Armstrong had to say, and it's only a notice. Here it is, all of it:

"The hours of work in these mills and shops shall be from 7 o'clock A.M. to 6 o'clock P. M., with intermission from 12 to 1 for dinner. On Saturdays, work will cease at 4 o'clock P.M., a full day's pay being allowed day-workmen for the short hours."

"Aint a word there about wasting material, keeping machinery clean, or how many ounces of waste shall be allowed for doing it. Nothing there that interferes with a man's conduct outside these mills, and it doesn't specify his conduct inside. It tells a workman what he wants to know and stops right there. Armstrong wrote that notice and I give him full credit for its being the best one for its purpose I ever saw. Just appeals to men as if you expected they were *men* and not cut-throats, robbers or murderers; and, somehow, when you act as though you thought you were dealing with men, you are rather apt to find men to deal with. I advise, Auker, that you pull down the new rules and regulations and put back Armstrong's little notice. Don't advertise that you keep men in whom you have no kind of confidence. Looks bad for the mills."

The Old Man closed the interview, as they say. When he advised a thing it might be said to be equivalent to ordering it, but then it sounded more easy-like. The new rules and regulations came down and the old notices went up, and Johnson hasn't heard any more about paying for the little break-down. About an hour after the interview the Old Man wandered careless-like into Johnson's engine room.

"Well, Johnson, how are you getting on?"

Johnson allowed that things seemed to be heading about right. Break-down might have been a serious affair, but as it was it was rather lucky.

"How soon, Johnson, are you going to get the help working and the mill making money?"

"Well, Mr. Argent, I have ordered material for a new rod and am watching out for it every minute. Mike has got up steam on the little help-out, and the joker is turning over the machine shop shaft. In an hour that rod will be turning around in the best lathe. Mr. Watson says that lathe won't stop for six o'clock or anything else, till it's done, and he just bet me the biggest cigar in Backaway that he'd lay the whole business right down

on this floor—complete, in thirty-six hours after the rod let go, and if I can't put it in place and ready to run in twelve hours, I ought to get another job."

"That's business; that's business, Johnson, but when you and Watson get your heads together over a job you just discount one another. Tell you what I'll do, and I'm going to bet to win, I'll set a box of them regular ten-centers, to smoke, on that desk, and if you and Watson get that job done in forty-eight hours from break to finish, every blessed man who strikes a tap to get things turning around is entitled to two smokes out of that box. Going to win once in a while. Tell you what it is Johnson, you're a lucky dog. Haven't had a break-down around that engine in five years. Lucky dog, but your luck's just gone this time; you won't win that box of cigars."

Then the Old Man took a turn or two around the engine, trying to whistle Yankee Doodle; went out of the door and that's the last Johnson saw of him.

Johnson won the box of cigars, and the boys smoked 'em.

Yours truly,
JOHN LOOKABACK.

* * *

States have nothing to fear from the passage of similar acts. The fact of application complies with the law until the license is granted or refused, so that in case of emergency a manufacturer can put any available man in charge of his plant as he can now by having him apply immediately for a license for the position.

The bill is so framed as to avoid any expense to the State, the fees for licenses being sufficient to cover the expenses of administering the law. It is not class or special legislation but provides for a public necessity with hardship to nobody and no increase of the public expenditures."

We know of several instances where the person named in the license which adorns the office walls, isn't in the boiler-room once a month, and are glad to note that this says "the person in charge." Mr. F. R. Low, well known from his work in the N. A. S. E., and as editor of *Power*, is urging its passage.

* * *

MODERN DRAFTING ROOM SUPPLEMENT.

H. M. NORRIS.

The subject of the modern drafting-room has been so many times embalmed and buried, only to be resurrected, and finally

Form 97.

1A Section....A........of **PRODUCTION LIST.** Continued on..................

CASTINGS

10 TON ICE MACH.

1267

Date. OCT. 8TH 96.

Del. C.H.R.... Ex. M.G.D.

CAMPBELL & ZELL CO.
BALTIMORE, MD.

NAME OF PIECE OR WHERE USED.	PATTERN & CORE-BOX MARK.	NUMBER WANTED	DRAWING NUMBER.	PIECES IN PATTERN.	NUMBER OF CORE-BOXES.	PIECES IN CORE-BOXES.	MATERIAL.	WEIGHT OF ONE PIECE.	REMARKS.
AMMONIA CYLINDER	1A1	2	306	2	3	6	C.I	560	SPECIAL C.I.
" TOP HEAD	1A2	1	307	3	2	4	"	30	" "
" BOTTOM HEAD	1A3	1	"	3	2	4	"	38	" "
" STUFFING BOX	1A4	1	308	2	1	2	"	25	" "
" FRAME	1A5	1	309	2	1	4	"	998	
BED PLATE	1A6	1	"	1	1	3	"	2470	

FIG. 1.

LICENSING ENGINEERS.

What appears to be a very sensible measure for licensing stationary engineers is now before the legislature of New York State. The plea for its adoption says: "During the past five years, the recorded explosions in the United States have averaged one for every working day, and an explosion rarely occurs without loss of life. Any attempt to prevent this by a periodical inspection of the boilers is futile, for the majority of the explosions are occasioned by neglect, ignorance and mismanagement. An ignorant or careless attendant can explode the best boiler on earth the day after it is inspected, and as a rule, the better the boiler, the more violent the explosion. This bill requires the examination of the men in charge, and makes it unlawful to employ any person, or for any person to serve as engineer or attendant upon a steam boiler or steam engine without having been examined and licensed. The examination is so shaped as to determine the competency and reliability of the man for the particular situation that he desires to fill, and licenses when granted apply to the particular plant regarding which the licensee has been examined and to no other. All the bill requires is that a man shall be a *safe* man for the position. It does not require the employment of a skilled engineer to run a threshing machine or a technical graduate to fire a sawmill boiler, but says distinctly, 'Every person who shall upon examination be found to be a *safe* person to take charge of the plant and apparatus mentioned in his application shall be entitled to a license.' Manufacturers and employers of engineers do not wish to employ an unsafe person in such a position and can have no objection to the bill as imposing any restriction upon them in this respect. The manufacturers of Massachusetts, where a similar law has been in effect for two years, declare freely in its favor and in answer to a circular letter assure us unanimously that the law has occasioned them no hardship, has improved the average intelligence and efficiency of their engineers and that the employers of other

condemned to the hidden archives in the minds of all good mechanics and engineers, that it may be dangerous to attempt to write anything further on the subject, but, like Lydia Pinkham's Compound, which is guaranteed to fill that long-felt want, I feel impelled to venture a few suggestions relative to a system which, though hackneyed in theory, is new and advantageous in practice, and has proved of much value to the shops in which it has been tried.

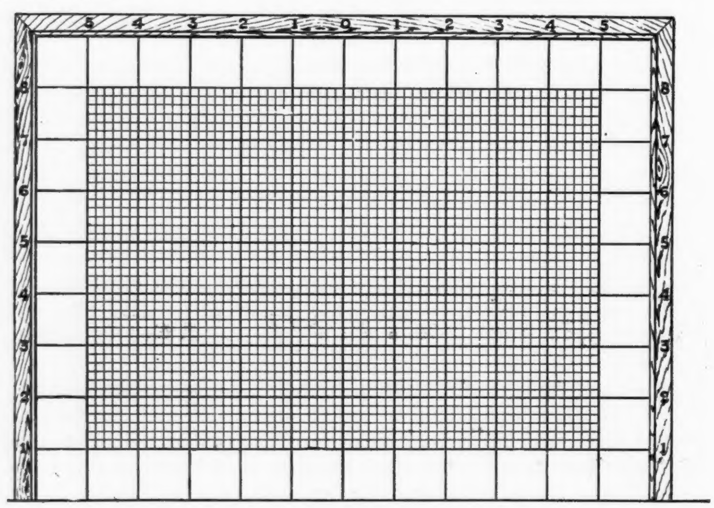


FIG. 2.

Figure 1 represents a form of production list, or specification sheet, printed upon thin unglazed bond paper, which, after being filled out as indicated, forms a complete history of genealogy of the parts of a machine, and makes it an easy matter to obtain as many copies as may be required, by means of blue-printing. This particular list applies to the smallest size of a family of ice

machines, known by the distinguishing letter A, and comprises a complete catalogue of all castings together with their pattern and core-box mark, number of each required for one machine, drawing number, number of pieces in each pattern and core-box, material of which each is made, and the average weight of each casting.

By this method, the pattern-maker has no trouble in selecting his patterns; the foundry man in knowing how many castings of each are required, nor the machinist in finding the drawings which apply to the particular job he has on hand. It is readily understood, acts as a guide to all departments, contains no red-tapeism, and, above all, renders the management of a company using it entirely independent of the memory of its men—an advantage not to be lightly passed over.

In figure 2 we have a section ruled black-board, made with ordinary mortar as a backing, and faced with white-coating heavily mixed with lamp-black. The mortar, in this case, was long always-in-the-way-and-out-of-order sliding straight edges and huge out-of-square, and split triangles; but is infinitely more convenient to work upon. The lines, besides enabling one to make a rapid free-hand sketch to scale, are of sufficient depth and breadth to guide the chalk, thus all straight lines usually drawn by means of a T-square and right angle triangle, can be made with one rapid sweep of the hand. But the advantages of a section-ruled board do not stop here--they are two-fold--for after a sketch of a machine is made, it can be photographed, and still read to scale, the lines presenting a fine hair-like appearance on the photograph, as seen in the illustration which represents a most hurried sort of sketch, but, being so many times reduced in size, looks almost as well as a thoroughly made drawing. This way, a sketch once made is never lost, nor is the board rendered useless until a certain Mr. Jones is able to come to Baltimore to see it. The draftsman, too, can work to far better advantage with the photograph before him when making his scale drawing,

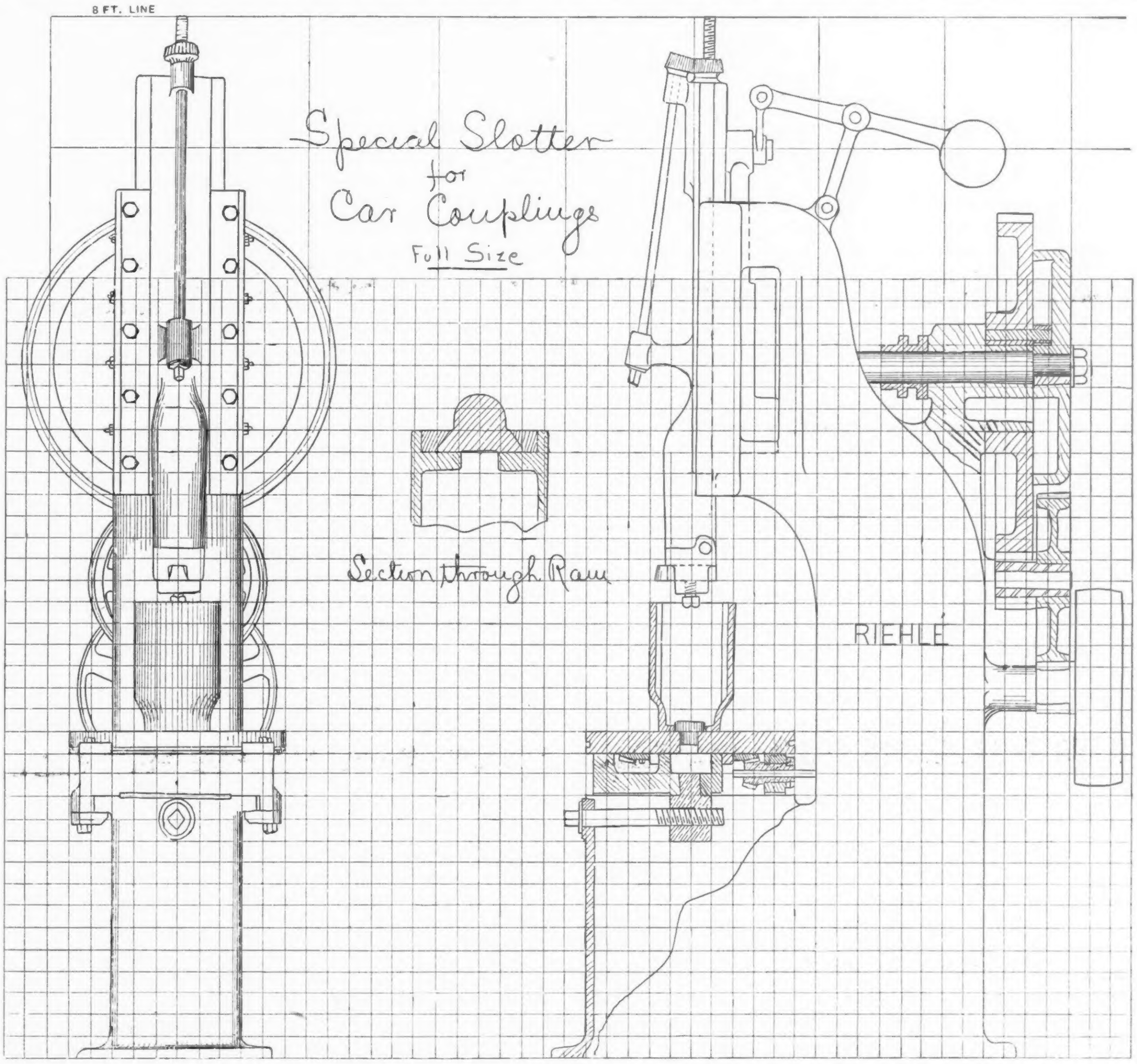


FIG. 3.

laid on a brick wall, and in sufficient quantities to make a true plain at right angles to the floor, after which it was allowed to stand until thoroughly dry and hard. The white-coating and lamp black was then put on in a layer about $\frac{1}{16}$ inch thick, and trowelled until perfectly smooth. This was permitted to stand until *almost* dry, when the ruling is done, and herein lies the trick. A scriber tore the surface, causing it to crumble along the edges of the line which presented a very rugged and unsightly appearance; a knife-blade puckered up, and drew the edges as when one blocks off a tin of caramels before it has had time to become sufficiently hardened. But a glass-cutter—one of those cheap ones with a wheel—worked like a charm, and made as perfect a line as that obtained by a sharp, hard pencil upon a sheet of soft drawing paper.

A black-board made and ruled in this manner, is not only much cheaper than the old time, plain surface boards, with their than if he had to turn to the board every time he wanted to read a dimension.

On the board illustrated the whole surface is ruled into two-inch squares to the height of a man's reach, but in making another, I should leave the outer band of one foot square spaces, which would make the foot distances easier to read, as shown on figure 3, and the center lines more easy to find.

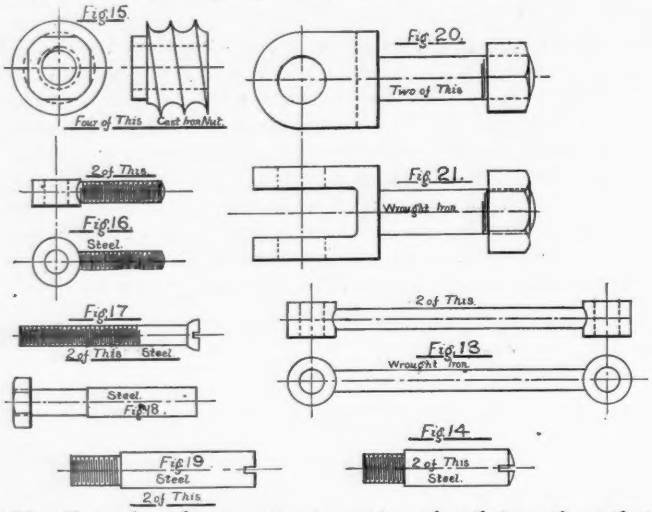
* * *

THE Ohio State University have issued a circular giving briefly such information as mechanics, desirous of securing a higher education, seem likely to want. While citizens of Ohio have the preference, others are welcome if there is room. The tuition is free; the other expenses are said to be very moderate. The University wishes to distribute these circulars widely, and will send to any employer as many as can be successfully distributed.

DESIGNING AN ENGINE SHAFT GOVERNOR.—3.

THEO. F. SCHEFFLER, JR.

Further details are shown in the following figures, 13 to 21. Fig. 13 shows connecting rods between weight and eccentric, Fig. 15 a detail of spring nut, and Fig. 14 the spring adjusting screw. The other details will explain themselves.



The dimensions from center to center of coils, are those that have been used by the writer in every-day practice, and which have proved the best for practical use ; they are calculated, too, with a good, reasonable factor of safety. To obtain the greatest admissible opening between each coil with safety, multiply the safe load in hundred pounds by the opening per coil per hundred pounds. For instance, referring to the table*, it will be observed that the safe load of ½ inch steel for 2¾ centers is 1043 pounds, and that the opening per coil for each 100 pounds is .0229 inch, therefore, we have 10.43 one-hundredths which, multiplied by .0229 gives .238 inches, which is the greatest admissible opening between each coil. Having found the correct pull on spring, it will now be necessary to assume the diameter of steel; to do this we refer to table, and in the column for greatest safe loads, pick out the spring that will come the nearest to the desired figure required for pull on spring; of course, we must be guided to some extent by the size of the governor, whether it is for a small or large engine. Having found the desired spring for the necessary load, it is now essential to determine the number of coils required in spring; of course, four of the coils are not active, as two on each end of spring are screwed on to the cast-iron spring-nut, to hold the spring by. The spring must be long enough, so that when opened up to its maximum tension, the distance between the coils will be within the safe limit of opening per coil, or otherwise the spring will stretch beyond its elastic limit, and if this is done, the regulation of the engine will be effected to a considerable extent, and the spring will be worse than useless. We will assume for an illustration that the initial tension of spring is 700 pounds, and the maximum tension 1043 pounds, to obtain the proper number of active coils for spring—assuming that the motion given to spring between initial and maximum tension is 3 inches, our difference in this instance is 343 pounds; therefore, multiply $3.43 \times .0229 = .0785$ inch opening per coil for the difference of lead, and dividing 3 by .0785, gives 38 for the number of active coils, and adding the 4 inactive coils, we have 42 coils altogether. The spring will open 9.044 inches at the maximum tension. In picking out the spring from table, it would be better to obtain one where the total number of pounds required would be a little under the preferred spring, as this, then, would give a little go-and-come on spring. Of course this would make a few more coils, and would probably necessitate a much larger pulley for governor than if a fewer number of coils were used. For instance, if our load on spring 1043 pounds, the safe load for spring should be approximately 1100 to 1200 pounds per spring, then refer to the table, and observe the opening in decimal parts of an inch per 100 pounds for the preferred spring, and multiply it by the difference between initial and maximum tension, as before in the number of 100 pounds, this gives the opening in inches and divide the motion in inches between initial tension and maximum tension that the weight has, by the opening of spring per coil of the total difference, this will give us the required number of coils. One feature necessary in designing a governor, which is also important, and that is to keep the motion down as small as is consistent with the required maximum force of weight, between initial and maximum tension, or the distance the weight must travel in order to move eccentric across the shaft and cut off the steam. The governor weight should be calculated in weight to give the required centrifugal force at the proper distance from center of shaft, and should be figured as though there was but one weight to move the valve; the other weight being sufficient to take care of the friction of the governor. There are various shapes used for the outline of weight—round, eliptical, oblong and spherical, and all are made to suit the peculiar design of the governor that they are to be used with. The distance from center of shaft to center of weight proper, should not always be taken for the measure of the centrifugal force, because it is not the theoretical point to calculate the force at; it depends very much on the form of weight used. The theoretical point of weight to measure the centrifugal force at, is the center of gravity of the weight and arm. When the design of weight has been determined, and if the weight proper is cast to the weight arm that the weight is suspended from, the center of gravity should be found either by calculation or by a mechanical method. The latter is preferable, and probably better satisfaction will be obtained. If the weight is of practical uniform thickness, a pattern should be cut out of the identical out-line of weight and arm, and the center of gravity ascertained by suspension; this method has already been mentioned in the description of crank-disc and counter-balance, and will apply to the governor weight with satisfactory results. The pattern can be made either of card-board or a very thin piece of wood; having the templet made, suspend it at three different points, and from the same point that it is suspended from, drop a plummet line, and where the second and third line passes or cuts the first line, this point will be the center of gravity. To prove it, make a center hole in the pattern at the center of gravity, and insert a needle or pin for a center, and then whirl the pattern around several times and with different force each time, and if it stops at different points on the circle you have obtained the true center of gravity. Then proceed to carefully measure the center of gravity and locate the same on the assembled drawing of governor; first locate it when the weight is at its inner position, then measure the distance from the center of gravity to the center of the shaft, and the distance in feet will be the distance at which the initial centrifugal force is calculated at, and also the initial tension of the spring. Then proceed to lay out the center of gravity at the other position of weight, and this distance will be the proper point at which the maximum centrifugal force is calculated at. The formula for calculating the centrifugal force is practically the same as used with crank-disc counter-balance, and which was used on this engine; the formula, however, is given below. Where a weight and arm combined, are used, and the lever or arm part of weight is perfectly straight and not part of a circle, and the thickness of weight and arm is nearly uniform the whole length, the center of gravity can be determined by balancing the pattern or templet on some sharp edge, by laying the templet of weight on its flat on the edged fulcrum, and measuring the distance from center of gravity to the fulcrum of weight. Of course, the center of gravity will be where the templet is thoroughly balanced on the sharp edge and through the center of weight arm longitudinally with its length. The center of gravity is more difficult to determine by calculating than by the mechanical methods just described, and is not near as practical nor as positive for exactness. The weight, however, can be calculated the same as the center of gravity of crank disc or a safety valve lever, by making careful measurements of the whole out-line of weight and calculating the different weights so as to form a ratio in determining the center of gravity.

Centrifugal force of weights:

Let C = centrifugal force in pounds.
" D = radius from center of shaft in feet to center of weight, or center of gravity of weight.
" R = revolutions per minute.
" W = weight of revolving body in pounds.

Therefore, $C = .000341 \times W \times D \times R^2$.

The weight of a revolving body can be determined from the following, using notation as above:

$$\text{Therefore, } W = \frac{2941 \times C}{D \times R^2}.$$

In designing a governor, particular attention should be given

* Published on page 186, in February.

to the position of springs, to have them as close to the hub of governor pulley as possible, to suit the condition of the necessary parts of governor; they should also have a very direct pull on the weights, being laid out as near as possible to a right angle; a small obtuse angle, however, will do no particular harm if not too great. A good pull should also be arranged for the eccentric connections between the weights and governor eccentric, and see that the link connections do not lock when at the inner or outer position, or cramp in any manner whatever. In regard to the spring, the idea of keeping it compactly against the pulley hub is obvious. When the spring is a considerable distance away from the center of shaft, the centrifugal force will amount to quite an item, and when it does, unless the spring is held in some good, practical manner at the center, between the ends, it will bow out at the center, causing unequal distribution of tension on the spring; not only this, but it bends the spring adjusting screws considerably, unless they are extremely heavy and ungainly. Where the spring is comparatively close to the center of shaft, the centrifugal force of spring at center is reduced to a minimum amount and it is not perceptible to any degree whatever, and consequently the spring will give better satisfaction if so arranged. On some designs of governors it is quite difficult to arrange the springs in this manner. For convenience of those purchasing the engines, and also for better experimenting with engines and governor when being tested at the shop, the weights are provided with detachable check-pieces of different thickness of metal, whereby a change of speed may be obtained by simply changing the check-piece on weight for either ligher or heavier ones, as the case may require, and also by changing the tension of the spring in one way or the other. Particular care, though, should be given to the springs when making this adjustment to see that perfect even tension is given to each spring, so that one will not have more work to do than the other. A difference of from 10 to 20 revolutions may be obtained in the above manner without changing the springs; should more of a change be required one way or the other, a new pair of springs will be necessary to secure good regulation, on account of destroying theoretical difference between no load and full load; that is, the point where the centripetal and centrifugal forces balance one another at any change of load or steam pressure, and where they are in perfect harmony with each other; if this difference point is destroyed, the regulation is also affected to a considerable extent. The pulley for governor can be used for transmitting power with belt or rope, as may be required if desired, but where there is a special wheel for transmitting power, the face of governor wheel can be made much narrower than would be required if arranged for belt.

* * *

THE BREAKING POINT.

The old deacon, we are told in poetry, built his wonderfu one horse vehicle on such lines that it couldn't break down, simply by fortifying the weakest part. This was probably quite right from the deacon's standpoint; but is it not a fact that too many machine designers look at the deacon's experience and follow his plans rather far? A machine gives way somewhere owing to an accidental and entirely abnormal strain. The point at which it gives way is forthwith fortified—strengthened before the next machine is built. The break did not amount to much, but it will not break there again. That may be just where the trouble is. Probably under the same provocation there would be a break somewhere, and this may have been just the place for it to occur. Purely from strengthening this inconsequential part, the next break may wreck the machine. The argument is this: The machine is bound to break if the accidental strain is sufficiently great. Then provide for the break occurring where the least damage will be done.

I do not say that this is never done, but it is not commonly done. It is the practice, to some extent, to purposely weaken the steam engine cylinder heads to the extent that they will break before the cylinder will give way, but what proportion of construction is deliberately planned to that end? The plan seems to be an excellent one, but never seemed to find extended favor. It ought to be universal instead of practically obsolete. What is true of cylinder heads is true in the instance of almost any machine. It is generally better to break something else rather than the main frame, and in the design to provide that the break shall be elsewhere. It is very often the fount of wisdom to weaken instead of strengthen some part, the breaking of which is of little consequence, even though it does not seem quite natural to do so. F. G.

* * *

VALVE GEARS.—5.

E. T. ADAMS.

The papers preceding this have been devoted to the interests of that class, usually neglected, whose opportunities for study are limited. The aim has been to lead the beginner to work out for himself the reasons for much that is usually accepted as fact without reason, and more attention has been given to an attempt to establish a habit of thought than to developing a method of designing valves; from this point on, however, the latter must be the chief object, and we shall take for granted all that we have so laboriously worked out in the preceding papers, making briefest reference to the practical application of the points so far brought out, as occasion arises.

When the line of action of the valve gear is parallel to the center line of the engine, as we have so far assumed it to be, and the crank is at A, Fig. 28, the eccentric, for a valve with no steam lap, will be at c and cut-off will occur at c^1 after the eccentric has turned through 180°, steam being admitted for the entire stroke of the piston. If we advance the center of the eccentric to d, the crank remaining at A, the valve will be displaced from its mid-position by the perpendicular distance from d to $c\,c^1$, which is equal to the radius of a circle drawn tangent to $c\,c^1$ and having d for a center, and as we have seen, this radius measures the steam lap that we must give to the valve to bring admission when the

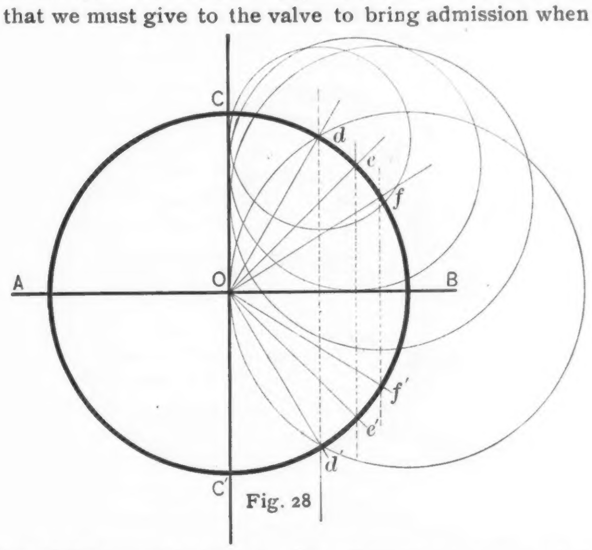


Fig. 28

center of the eccentric is at d. Cut-off must now occur at d^1, or 180° less the sum of the angles $c\,o\,d$ and $c\,o\,d^1$, or since the two latter are equal, at 180° less twice the angle $c\,o\,d$; or if we advance the eccentric still further, say to e, the crank remaining at A, the steam lap must equal the radius of the circle tangent to $c\,c^1$, and having e for a center, cut-off now occurs at e^1, which, as the angle $c\,o\,e = 45°$, brings cut-off where the eccentric and consequently the crank has turned through the angle, $180° - 2 \times 45° = 90°$, that is cut-off is at about ½ stroke. Advancing the admission position of the eccentric still further to f, the valve is displaced from its mid-position by the perpendicular distance from f to $c\,c^1$, that is, as we see from Fig. 28, the lap is still greater while the time during which the valve remains open is less, which is another way of saying that cut-off will occur still earlier in the stroke of the piston.

This angle through which we turn the eccentric to bring it from its mid-position to its admission position is an important factor in valve design, and is called the *angular advance* of the eccentric. If the throw of the eccentric remains unchanged, greater angular advance means increased steam lap and an earlier point of cut-off. As we advance the eccentric from f toward B, cut-off will occur earlier as the angular advance is made greater, until when the center of the eccentric reaches B the angle turned through from admission to cut-off becomes zero, that is, the valve does not open at all, and the steam lap B o is seen to be equal to the throw of the eccentric.

It is self-evident that the maximum displacement of the valve from its mid-position occurs where the center of the eccentric is, either at B or A, and if the port is opened at all this position must give the maximum port opening. To find how great this

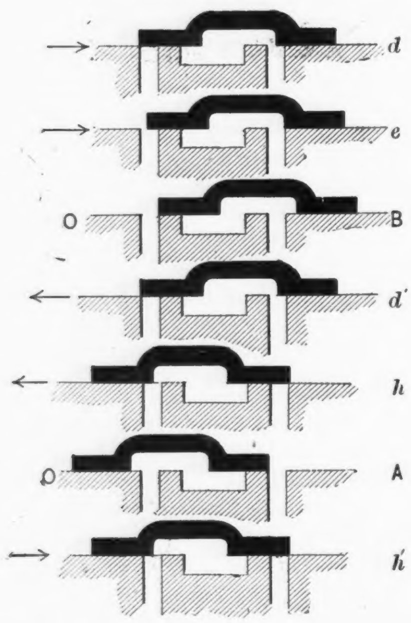
maximum opening will be, we will suppose that the center of the eccentric is at d when admission occurs, the lap of the valve is the distance 1, Fig. 29, the angular advance is $c\,o\,d$, cut-off will occur at 180° less twice angle $c\,o\,d$ = about ¾ stroke, and the angle between the eccentric and the crank is angle $c\,o\,d$ plus angle $c\,o$ A, or the angular advance plus 90°. Now as the crank and eccentric turn as shown by the arrow, the valve is carried further and further toward the right, and when the eccentric reaches some point, as e, the total displacement of the valve will equal the perpendicular distance from e to $c\,c^1$, and the port opening must equal this distance less the radius (1) of the circle, or *the port opening is equal to displacement of the valve from its mid-position less the steam lap.* At B this opening is a maximum and is seen to be equal to B o less 1, or to the throw of the eccentric less the steam lap. After the center of the eccentric passes B, the valve begins to close, and when the eccentric reaches d^1, which, as we have shown, is the eccentric position for cut-off, we find the circle which we may call a *lap circle* is again just tangent to $c\,c^1$. Notice that the valve is always either closing or opening, that is, the edge of the valve is line and line with the edge of the port where the lap circle is tangent to $c\,c^1$. At h the valve has passed to the other side of its mid-position by a distance equal to the lap. The lap circle is tangent to $c\,c^1$, and the valve is just ready to admit steam for the return stroke. Cut-off for the return stroke must occur where the eccentric center reaches h^1 with the lap circle again tangent to $c\,c^1$. The positions of the valve corresponding to each eccentric position are shown in Fig. 29, each valve and corresponding eccentric position being designated by the same letter.

We have so far traced the positions of the center of the eccentric relative to the line $c\,c^1$; we could just as well have traced the motion of the line relative to the center of the eccentric, for it is evident that the relative motion of the two would have been the same if we had conceived that the eccentric was fixed, say at d, while the line $c\,c^1$ was moved. No matter which is moved, provided the relative motion is the same (that is, in this case, the first motion should tend to move them apart), the perpendicular distance from d to $c\,c^1$ will still measure the displacement of the valve from its mid-position, and this distance less the lap will still be equal to the port opening.

Going a step further, why not take a line and a point anywhere? By selecting proper positions we could still get the same results as before, and this is exactly what is done in the Bilgram diagram. The motion of the crank relative to an arbitrary point is traced instead of following, as we have just done, the motion of the eccentric relative to an arbitrary line. In the Bilgram diagram the line chosen is the line representing the crank; for admission positions this would be the line A B, Figs. 28 or 29, and with reference to this a point, which Mr. Bilgram called "the fixed point Q," is so located that the perpendicular from the point to the line always represents the displacement of the valve from its mid-position. Clearly this is exactly what we had before, and far more convenient than following the changing eccentric positions, since we always refer to cut-off, release or admission as occurring at some known crank or piston position, while the positions of the center of the eccentric are seldom thought of, in this connection. It can easily be proved that the motion of the crank relative to Q is exactly the same as that of the eccentric relative to the line $c\,c^1$. Those of our readers who cannot prove this for themselves, yet who wish to *see* that it is true, should make a tracing of the line $c\,o\,c^1$, Fig. 28, and of the point d, when this tracing is reversed and laid on Fig. 30; $c\,o\,c^1$ falling along A o B, d will be seen to coincide with Q, when O falls on O. These are the positions for admission if any other corresponding positions are taken the result will be found to be the same.

The Bilgram Diagram. While the crank-pin traverses half the circumference of a circle, the piston traverses a distance equal to its diameter. Any circle, therefore, will represent, to some scale, the crank circle of any engine, and the diameter of this circle will represent, to the same scale the stroke of the piston or crosshead. Since we have made our indicator cards 4 inches long, it is convenient to take A B, Fig. 30, as the same length, or if the points of cut-off, release, etc., are to be expressed in decimal parts of the stroke, then for obvious reasons it will be easier to take A B = 5 inches. Points A, c, B, etc., along the circumference of the circle, represent positions of the center of crank-pin and lines as A o, or A o extended or $c\,o$ represent crank positions; we will show later how to locate piston positions on the diameter A B, corresponding to these crank positions. The fixed point Q can be located in several ways, as we shall see presently, but its characteristic is that for any crank position, the corresponding displacement of the valve from its mid-position is measured by the perpendicular drawn from this point Q to the line representing the given position of the crank. For example, in Fig. 30, the perpendicular distance from Q to A B, which is the crank position for admission, exactly equals the distance that the valve has moved from its mid-position at the time that the crank-pin has arrived at A. This distance, again, is exactly equal to 1, Fig. 29, the perpendicular distance from the center of the eccentric to $c\,c^1$ when the crank is at A. This distance is the steam lap of the valve. Angle Q o B, Fig. 30 (=angle $c\,o\,d$, Fig. 29), is the angular advance and the distance Q O, Fig. 30, = $d\,o$, Fig. 29, is the throw of the eccentric. Fig. 29 shows the true relative positions of the crank-pin A and the eccentric d, also the changing positions of d relative to the arbitrary line $c\,c^1$. Fig. 30 gives the true position of the crank relative to the fixed point Q. Keeping these two figures in mind, the reader will find it very easy, if he wishes to do so, to derive from the Bilgram diagram, a diagram similar to that in Fig. 29, showing the true positions of the crank and eccentric.

To locate the point Q there are a number of methods, depend-



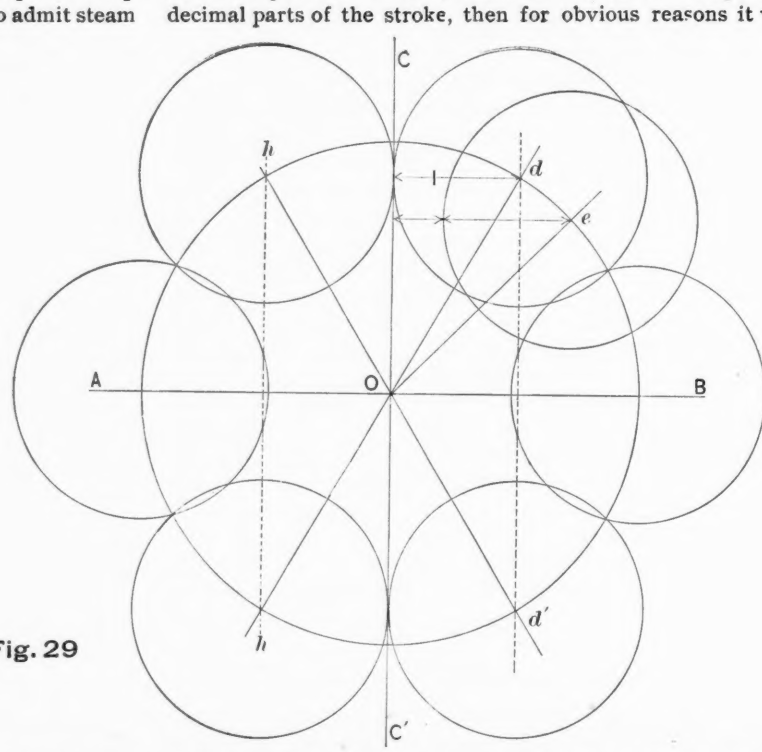


Fig. 29

ing on what data is known, but as the problem comes up in the shop one is usually given either the maximum port-opening and the latest point of cut-off, or in the case of an old engine, the throw of the eccentric and the lap of the valve is known, either combination gives all the data necessary to find angular advance, maximum port-opening, or any quantity that will be needed in design or construction. In a new design, the port-opening and cut-off, or the cut-off and the throw of the eccentric, are usually known. The port-opening for any case can be figured, as will be shown in a subsequent paragraph, and the latest point of cut off may be calculated or assumed, in any event it is a known quantity; so there is little need for any "cut and try" process in design. We will take cut-off at ¾ stroke and the port-opening we will also assume as ¾ inch. Draw A B, Fig. 30, the crank position for admission; we have so far neglected lead; assume that there is no lead, locate o, and with this as a center draw a crank circle 4 inches in diameter (it is not necessary to make this 4 inches; an unknown diameter would do as well, except for convenience in drawing theoretical indicator cards). Next taking a distance equal to the maximum port-opening as a radius, describe a circle about O as a center, in this case *o x*, the radius of the circle = ¾ inch. Note particularly that there is no need that the port-opening, lap, etc., shall be to the same scale as the crank circle; from the latter we take only crank positions, crank angles or piston positions expressed in percentages of the stroke, all of

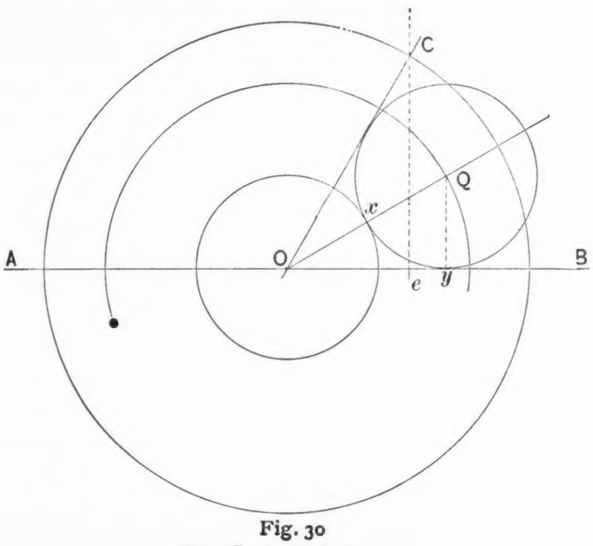


Fig. 30

Ox = Port-opening
Qx = Qy = Steam Lap
OQ = Throw of Eccentric
QOB = Angular Advance

which are independent of the diameter of the crank circle, hence the rule. Draw the crank circle any convenient size, but always lay off the port-opening, lap, etc., actual size, or double size if the valve is small.

To locate the crank position for cut-off. In this case, for example, cut-off at ¾ stroke is required, that is, cut off when the piston has completed three-quarters of its stroke. Now we know that, as a rule, this point of cut-off is not the same for both forward and return strokes. We will discuss this presently, but if we take this in its usual sense, meaning that the *average* point of cut-off, considering both strokes, is at three-quarters of the stroke of the piston, we can locate a crank position that will give this average point of cut-off, as follows: Since A B represents the stroke of the piston when A C B represents the crank circle, lay off from A, A *e* = ¾ A B, erect at *e* a perpendicular cutting A C B at C. C O is the required crank position. We shall see presently that cut-off will now occur when the center of the crank-pin reaches C, but in neither the forward nor in the return stroke will the piston be just at three-quarters of its stroke when cut-off occurs; however, the *average* for both strokes will be just three-quarters as desired. When cut-off is spoken of in this way to designate the average position of the piston when cut off occurs at some known position of the crank, it is called "nominal" point of cut off to distinguish it from the two actual cut off positions of the piston, of which it is the average.

Now find by trial a circle tangent to C O, A B, and the circle of maximum port-opening. The center of this circle is the fixed point Q. Its radius is the steam lap; Q O B is the angular advance; Q O is the throw of the eccentric, and Q *y* the perpendicular from Q to A B (equal to the steam lap), is the distance that the valve will be displaced from its mid-position when the crank is at A. The exhaust lap necessary to bring release or compression at any desired point, or the reverse problem, can easily be worked out from this same diagram; but we will reserve this until the next paper.

* * *

NOTES FROM NOTOWN.—17.

Ichabod Podunk.

BROWN'S NEW SUPERINTENDENT — PATCHING UP THINGS.

There is a new superintendent at the old shop on the next street, and he seems to be shaking things up generally; seems to be a hustler and has a way of getting things which is breezy and interesting, even if it does make the owners squeal a little once in a while.

The shop was in bad shape; had been poorly laid out to begin with, and had been made worse by the promiscuous additions of different foremen. The machine department was scattered over four stories, the pattern-shop and other departments were about as bad, and as a consequence the cost of the work was high.

Well, Johnson began straightening things around to suit his views; among the changes was the throwing out of about 20 muley belt drives, which had been put in to drive as many lathes, to satisfy some one's notion of having the tools at right angles to the wall. He was just completing this change when the senior partner came around, and the conversation that followed was about as told to me by an apprentice boy who worked near the scene of conflict, minus a few adjectives which might burn a hole in the page if printed:

"What are you doing here, Johnson?"

"Throwing out a few muleys, a few hundred feet of belt, and a whole heap of trouble, besides saving room in the shop."

"But, I don't want things changed so."

"Can't help that, Mr. Brown; shouldn't have hired me as you did. I'm going to change the whole arrangement of the shop as soon as I can get to it."

"But I won't have them changed so; we always got along with them as they are. I tell you not to change another thing without my consent," and Mr. Brown was rapidly getting into a passion.

"Mr. Brown," said Johnson, "there's just one way to stop my making changes. Come into the office and give me a check for the year's salary, and I'll be in Boston again, inside of 24 hours. Our contract was that I should improve the shop methods, reduce the cost of production and put this place on a paying basis. I'm doing my end of it, and won't be interfered with. Your consent will not be asked for a single change, and the only way you can stop them is to hand over the check I mentioned. If I don't fulfill my contract by the end of the year, you can fire me and sue for damages; if you don't fulfill yours, I'll do the same. So just keep cool and you'll be happier, as well as making things more pleasant all around.

"Next thing I'm going to do is to collect all your light machinery in one department; your heavy tools on the first floor; put your pattern-shop on the top floor, and you'll have room to let—beside getting out more work. By the way, Mr. Brown, I want a new planer, a couple of arbor presses and two drill presses, as soon as possible; your losing money every day you're without them."

"Where are the old ones, Johnson; they always did good work, and we can't afford to buy new tools this way. Do you expect to save money for us at this rate. Guess you're one of these reformers—want everything new or you can't work. Call that reducing cost of production?"

"Easy, now, Mr. Brown, or I'll have to call an ice wagon to cool you off. The worst planer of the lot is out on the sidewalk. It's of no use as a planer; may be worth half a cent a pound for scrap, but it was in the way and couldn't take a decent cut once a week. You can plant ivy round the legs and let it grow over it if you want it as a monument, but it don't go back into the shop while I stay here."

Mr. Brown fumed around awhile, but the thought of paying a year's salary for a month's work, kept him within bounds, and he let Johnson alone, fearing—if not hoping—that he would ruin things before his time was out.

As I'm interested in these new men, I asked the bookkeeper of the concern the other day, how the financial end of the new shop management was coming out, and he told me that on the last lot

of machines the labor cost had been reduced nearly one-half; that the cost of new tools must go against this, but he figured that by the end of the year the machines would cost about 75 per cent. as much as formerly, besides having many new tools in the shop. That isn't a bad showing, and I guess that Mr. Brown will forget his temper and hire him again, if he doesn't get a better chance somewhere else.

Wages were not reduced either, but in most cases the men earned more, for Johnson had caught the premium plan fever somewhere or other, and introduced it immediately. The men like it, as it gives them a chance to earn a little extra if they want to, and there isn't the fear of a cut that the plain piece work plan has. This all depends on the honesty of the boss, however, and too many of them don't see that they kill the golden egg, or the golden goose—or some such thing that you read about, but never see—when they are unfair to the men.

I was reading a patent medicine ad. the other day, which showed a picture of a man on a step ladder driving home a key in the main driving pulley of a factory. The tale of woe was something as follows: "A big mill was shut down, machinery paralyzed, no one could do anything." Repair man came, sized up the situation, said "Gimme a nail, etc.," and proceeded to key the main driving pulley with a *nail*. Then the great and only medicine was compared to the nail as being the thing required to start the life blood and insure living to be 817 years old. Whoever wrote that ad. knew just about as much concerning machine shop practice as some men I've seen trying to run a business.

Old Crocker's shop can probably discount the nail business, and can show keys of this kind by the score, only they are not driving main shafts by a good deal. Most of them are doing duty as "splines" or "feathers" in various old machines about the place, as Crocker is always too busy to fix things, and as a consequence often spends more time with some makeshift than it would take to make it right. There are too many who indulge in this "fix it up for this job" business. There are times when a ready makeshift is worth dollars, but as a steady diet it pays to fix tools instead of always patching up.

* * *

THE OFFICE OF CHIEF DRAFTSMAN.

G. Edward Smith.

The position of chief draftsman is, in many ways, a most trying one and requires more than a simple knowledge of the profession, for such it really is, to fill it properly. A chief draftsman should, in the first place, be a good leader and manager of men and be able to get along with even those of somewhat unpleasing dispositions. He should never attempt to force his position upon his subordinates by petty acts of authority. It is a great mistake to think that all men should be treated alike. They cannot be if the best work is to be obtained from them. This one may need to be kept under strict surveillance, that one kindly yet not familiarly dealt with, another allowed certain privileges which it would not be compatible with good management to give others, and yet these privileges must not be such that the charge of favoritism can be brought. It frequently requires pretty careful judgment to tell where leniency ends and favoritism begins. Again, the men should not be allowed to forget that respect due a higher officer by undue familiarity, particularly during business hours. Any one in command, so to speak, should study the character and temperaments of his men and apply the results of his deliberations in the management of them. When a man considers those under him and treats them kindly, he in turn will be looked up to with respect, both as a superior officer and as a friend; but when he shows his authority in petty matters he not only loses the confidence of his men, but also their best efforts.

In some cases there is a tendency to give a graduate of a technical school preference in certain work over another man more deserving and really a more able draftsman, who is self-educated. Then, too, if the chief be a self-educated man, he may do the opposite of this and give a young technical graduate little or no chance of getting the practical experience he so much needs, although the non-appreciation of our services does much to take away the conceit that goes with a graduate course, and if not sufficient to cause discouragement, is frequently a good thing for a young man.

When boys or apprentices coming from the shops take an interest in their work, they should be given as many small drawings of unimportant jobs as possible to start with, and not be kept on tracings until they are thoroughly disheartened. In most cases it is really cheaper to keep one or more professional tracers to do this work and give the boys some of the other work. One good tracer can do the work of three or four boys in that line. It is a mistake to crowd the office with boys, because they cannot then get a fair show. It is better both for the company and the apprentices to give half a dozen a good chance than a dozen a poor one.

In many cases a person in charge will often almost involuntarily make changes in design which really do not benefit it all, and yet simply tend to show his authority. Before making alterations the gain thereby should be carefully considered, and unless the improvement is real or the cost of manufacture reduced materially, the work should be allowed to remain unchanged. No unprejudiced man objects to making changes that really either improve the design or reduce the cost of a job, but it is very annoying to be required to make them simply because the "boss" thought of it, and it often causes very uncomplimentary remarks to be made, beside the loss of respect for him. A man is more interested and does better work when he feels that his suggestions have some weight with those in authority, and when he feels the work he turns out is the product of his brain and not merely his hands. Often changes are made for which the draftsman can see no reason, but for which there is a legitimate one, and all should be careful in their criticism, which is frequently unfair, as both sides of the question cannot be considered, either because it is deemed best for the interests of the company that certain points should not be openly discussed, or from the unintentional neglect on the part of the chief to mention his reasons for the change, or from other causes.

One of the principal duties of a chief draftsman should be to weigh the different suggestions offered and pick out the best, not to make mere machines of the men, and attempt to make the work of the office simply the application of his own ideas. This last method, which I have seen but too frequently tried, causes dissatisfaction among the men and is injurious to good work, for it is by the comparison of ideas and the moulding of them together we get our best results.

There is another point which is most important both from the economical standpoint and with regard to the men. It is the arrangement of work, as far as possible, such that one drawing follows another in the order of the construction of the work, and not make it necessary that one drawing should wait when partially completed until another is started and carried a certain distance in order to obtain necessary data. The work should be kept moving along together, and so far as it can be conveniently done, and no drawing started until it can be pushed on to completion at least in lead pencil. It is generally best to get out the principal details in pencil only, and then assemble them on the general arrangement, so that any alterations that are necessary may be made before the drawing is traced. When auxilliary machinery, fixtures or connections are made by outside parties, the drawings or blue-prints of same should be obtained as early as possible, as failure to have them frequently causes great delay in the completion of the arrangements and details with which they connect. Beside the loss of time incurred by the delays, it is discouraging to the men to have to discontinue their work, and it also increases the factor of error, as different points are liable to be overlooked in the intervals of waiting.

Another thing which is often neglected and is most important in large establishments where there are many draftsmen employed, is the publishing of bulletins regarding holidays and other affairs. In the case of holidays, when the men do not know positively about them, a notice should be published at least a week ahead, in order to allow plans to be made for them. Bulletins should also be posted regarding time allowed off and dates for taking vacations, where the latter are arranged by the company, so that should they not suit the draftsman he can arrange for the change while there is time. There are numerous other notices of regulation, etc., etc., which should be bulletined and not sprung upon the men unawares.

There is one grievous fault all are liable to fall into when they acquire a superior position, and that is the faculty of shifting the blame for errors and allowing it to rest on the shoulders of the subordinates, while praise for good work is allowed to remain with them, without seeming to cause the least discomfort. A word of praise now and then is tonic for the least of men as well

as the best, and tends to soften the stool on which the draftsman sits, and also the board over which we must lean for eight hours or more a day.

When a man steps into a high position from a technical school without much practical experience over the board, it is a difficult matter to run the office without unpleasantnesses, as he has not had the chance to discover, through the medium of being ruled, the little things which frequently make the life of a draftsman miserable. It is also difficult to arrange the routine of work in the most economical manner, as many points can only be observed from the lower position of ordinary draftsman. There is nothing like practical experience both as a teacher and a broadener of the mind. Theory is a most important thing, but it requires practical experience to teach us how to apply the theoretical part of our knowledge.

Let those of us who have been fortunate enough to rise to the degree of ruling others, either though that large factor known as "pull," or by the recognition of our merits, remember the things we found unpleasant when subordinates, and try to avoid repeating them in our intercourse with those we have in charge.

* * *

THE COMING EXPOSITION AT PARIS.

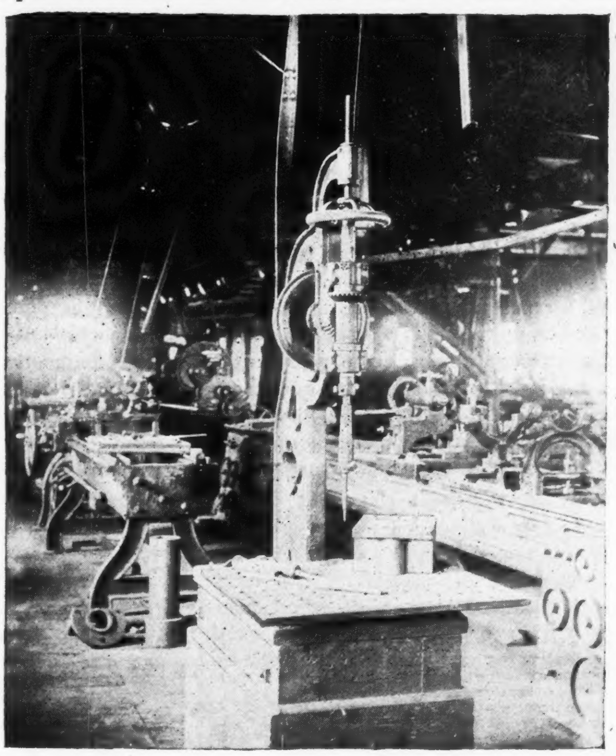
Consul General Moras, at Paris, transmits to the State Department at Washington a report that elaborately sets forth the preparations for the 1900 Exposition in that city, which will open, so it is said, April 1st, 1890 and close November 5th of the same year. Those who witnessed the Paris exposition of 1889 and noted its environments, and who, also, have in mind the surroundings of these exposition grounds will understand something of what is to come when told that the grounds upon which this exposition is to be held, will extend from the Place de la Concorde, the most magnificient square in the world, to and beyond the Champ de Mars, including a large section of the noted Champs Elysee.

It would be impossible for any city in all the world to donate a finer position for a great exposition than this. It will be, beyond much doubt, the greatest exposition of the kind ever held.

* * *

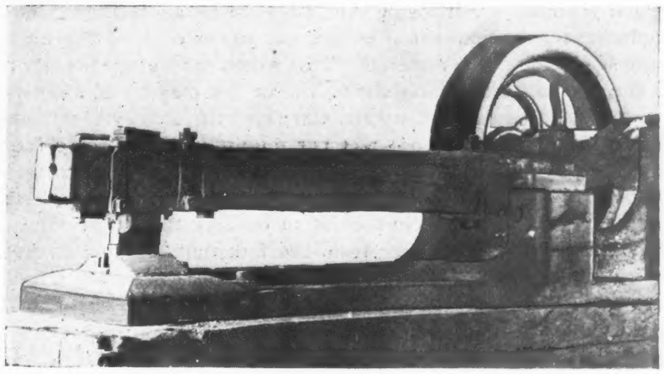
MORE OLD-TIMERS.

Another interesting relic from the shop of Gage, Warner & Whitney, of Nashua, N. H., is the drill press shown in Fig. 1, which looks like one side of a light planer housing, being quite deep in line with the normal strain, but with a web about as thick



as a shingle or, as has been said, "so thin that it had to stand twice to make a shadow." The table was built up of wooden blocks, as can be seen. There is nothing else specially noteworthy about the machine, the feed being operated by the hand wheel shown above. The twist in the belt indicates that it is a little loose, and that the man running it had indulged in the old trick of twisting the belt rather than taking it up.

The old helve hammer stood in the basement, the fly-wheel shaft having corners which looked something like bunions, which raise the hammer head and let it drop on the object when the corner passes the end of the helve. How long this had been installed is hard to say, but evidently for years. In this connection it may interest those who sometimes indulge in amateur photography to know how this was obtained. The hammer was quite inaccessible on account of the arrangement of



forges, and I could not get near enough to make a respectable sized picture with both combinations in the lens. By taking out the front combination and leaving the back one in place, I had a single lens with approximately double the focal length of the lens in ordinary condition. There is nothing new or wonderful in this, it is simply a trick of the trade which came into play quite handily, and may assist others. It has been done for years by those who were acquainted with it, but that makes it none the less new to those who did not know of it.

* * *

HIGH SPEED BELTING.

M. E.

MATHEMATICS AND MACHINISTS.

In the interesting correspondence which Mr. Cheney's attack on the "Wide Belt Heresy" has provoked, one aspect of the question, so far as high speed belting is concerned, has been either ignored or over-looked. I refer to the stress induced in the belt by centrifugal action—a stress, aptly, if not accurately, designated "centrifugal tension." I am aware that the average belting manufacturer finds it convenient to leave this factor out of consideration, in calculating the horse-power which his belting will safely transmit, but he can only consistently do this when the belt speed does not greatly exceed 2 000 feet per minute. With the frequently used speeds of 5 000 or 6 000 feet per minute, however, centrifugal tension becomes one of the most important considerations in the transmission of power by belting.

To illustrate this point, let us take the case given by Mr. Grimshaw, page 114, who, in order to improve the dynamo drive, suggests running a 28 inch pulley 960 revolutions per minute. This corresponds to a belt speed of about 7 000 feet per minute, or $\frac{7000}{60}$ = 116.6 feet per second. If we take the weight of a running foot of belting, 1 square inch in section at 0.43 lbs., the centrifugal tension at the speed named will be

$$\frac{0.43 \times 116.6^2}{32} = 182 \text{ lbs. per square inch of section.}$$

In other words the belt will be subjected to a tensile stress equal to, if not greater than, that which it is often popularly supposed to carry when transmitting a reasonable load. But this stress is acting on the belt *when no power is being transmitted.* The stress due to the transmission is entirely additional to this "speed stress," and the belt will therefore be subjected to about twice the tension at this speed; that would be considered "allowable" by many, at say—2 000 feet per minute. This certainly does not sound reasonable.

If it is considered that the material of a belt is only good for 180 lbs. per square inch, * at a moderate speed of say 2 000 feet per minute, it is clear that at 7 000 feet it must be severely overtaxed. There is, of course, no way of eliminating the stress due to centrifugal action at high speeds, but it certainly can be miti-

* See for example, Kent's Mechanical Engineer's Pocket Book, p. 877, rule 2.

gated to a very considerable extent by increasing the sectional area of the belt. The first result of this will be to increase the centrifugal tension just in proportion to the increase of sectional area, but the stress per square inch due to the transmission of power, will be diminished in a like ratio, so that the total stress on the belt will be reduced. Whether this additional area is best obtained by increasing the width or the thickness, is a debatable point.

Mr. Cheney says (page 10) that in a properly designed machine, the belt "should be *narrow* enough so that it *cannot* be stretched tight enough to bring more pressure on the journal than it is designed to stand." Supposing such a belt to be adopted and that the initial tension imposed is within, say 30 per cent. of the ultimate strength of the material. This would ensure the pressure on the journal being materially less than the maximum, and, so far would, I presume, satisfy Mr. Cheney. But it is evident that to run such a belt at 7 000 feet per minute would increase the stress to such an extent that it would break. *But the pressure on the journal would not be increased beyond that due to the initial tightening.* It is important to observe this latter point, which, it will be seen, results from the fact that the sum of the radical tendencies of the several portions into which the curved part of the belt may be considered to be divided, is equal and opposite to, and therefore counter-balances the centrifugal tension induced in both sides of the belt. Of course, the case taken is a hypothetical one, but it will serve to direct attention to this not unimportant aspect of the question at issue. It is readily seen, moreover, that the stronger and lighter the belting material used, the less the influence of centrifugal tension becomes and the higher is the maximum "economic speed" of the power transmitter.

Mr. Arthur B. Babbitt's contribution on "Mathematics and Machinists," in your January issue, is one which should be taken to heart by those machinists who are so fond of indiscriminately abusing the use of formulæ. These intensely *practical* men apparently fail to perceive that in doing this, they are, as a matter of fact, actually condemning a peculiarly practical device and are therefore, running a risk of forfeiting their claim to a distinction upon which they specially pride themselves. I have met with many who would give due consideration to a lengthy and cumbrously-worded *written* rule, but who would never condescend to examine the same facts if presented in the much more convenient form of an algebraic expression or formula.

This may appear a small point to make, but it is one that has to be reckoned with, for—until the practical man becomes sufficiently practical to overcome his senseless prejudice against the representation of quantities by letters, we shall continue to hear hard things said about mathematical formulæ.

Coming now to formula-users, a point which deserves mention is the failure to discriminate between what might be called "natural" and "empirical" formulæ. In the first variety, instances of which are afforded by the laws of falling bodies, the rules for mensuration, etc., there is here no room for differences of opinion, and no "personal factor" has to be taken into consideration. With empirical formulæ, however, we are constantly meeting with statements which are at variance with others that seem equally entitled to acceptance. This is not difficult to account for when the many possibilities of divergence in formulating such rules, are taken into account. How, for example, can consistency be expected in such a simple matter as the ratio of the length of a gear-tooth to the pitch, when one authority is prepared to sacrifice everything to secure maximum strength of tooth, while another considers smoothness of running a much more important factor?

Formulæ for the strength of gear teeth are notoriously inconsistent, but this is fully accounted for by the number of variable elements which enter into the question. The relative length and thickness of the tooth, the ratio of the face of a gear to its pitch, the way in which the load is assumed to be imposed—resulting either in corner bearing, even distribution of pressure over the face of the tooth, as a compromise between the two—and finally the number of teeth assumed to be simultaneously engaged, are all variable factors which may be modified in an infinite variety of ways. To this we have to add the marked divergence of opinion as to the suitable stress which should be allowed on the material, and the modification, even of this, for high speeds and shocks. Is it a matter for surprise, then, that with all these factors to ring the changes upon—many of which may be entirely ignored by some, or given an exaggerated importance by others—that our cut-and-dried formulæ for the strength of gears give such widely divergent results?

In the matter of fly-wheel formulæ, we have again an instance in which it is idle to expect any two rules to agree, unless formulated under similar conditions. Even approximate agreement is out of the question when one expression, giving the weight of a wheel for an electric light engine, is compared with another which aims at no closer regulation than is necessary in driving punching and shearing machinery or pumps. When a speed fluctuation of, say 5 per cent., allowable in the latter case, is reduced to 1 per cent. in the former and thus necessitates a proportional increase in the wheel weight, it is surprising that we find even so close an agreement among the various rules, as we do.

There is still another complicating factor, however, which should not be lost sight of and which, in fact, must be taken into due account in any rational formula for the weight of fly-wheels. I refer to the variation of crank effort driving a cycle, in different engines, depending as it does, upon the ratio of expansion, the disposition of the cylinders, etc. An investigation of the weight of a wheel needed for a cross compound engine working under usual conditions, will show that a very much lighter wheel is called for than is needed for the same cylinders placed tandemwise; while a comparison of the latter with the weight required in order to secure the same degree of regulation in an "Otto" cycle gas engine shows, as might be expected, a considerably greater difference still.

The moral of all this is that all empirical formulæ should be accompanied by a statement of the conditions which are assumed in its formation and as to limits between which it is applicable. If this plan was more generally followed there would be little ground for complant, as to the inconsistency of formulæ, and the practical man would view with more kindly consideration, the "mathematics" which he is now prone to regard with suspicion and distrust.

* * *

WATER TUBE vs. SHELL BOILERS.

W. Barnet Le Van.

Mr. H. M. Norris, in your January issue, under the title "Systematic Boiler Designing," says: * * * "And as the necessity for economy in fuel consumption becomes still greater, and the dictates of prudence demands the safest, the sectional, or water tube boiler is selected, this being the only type that I consider suitable to place under a building—the installation of shell boilers involving too great a risk to both life and property."

Mr. Norris does not designate the character of water-tube boilers, and, as is well known, the majority of them have a large shell over the top in which the steam is disengaged from the water, commonly known as a steam drum.

Again, if Mr. Norris will consider the number of persons injured and killed by the use of the water-tube boilers in comparison with like casualties by shell boilers, he will find the former to be equally destructive; and as to the economy in fuel, the shell boilers will excell the water-tube boilers. Take the trials of boilers, for proof of economy, at the Centennial Exhibition in 1876, and compare the Lowe and the Galloway shell boilers having flues through the inside to pass the products of combustion through, thence around the shell over the top of the boiler to the chimney, with the Root and the Babcock and Wilcox water-tube boilers respectively, in which the gases pass around the water-tubes and both of the shell drums, thence downward into the chimney.

COMPARATIVE TABLE NO. 1.

	Water Tube		Shell Boilers.	
	Root.	B. & W.	Lowe.	Galloway.
Heating surface area (total)	1598.43	1676.32	753.64	852.54
Fire grate area	42	44.5	22.5	36.0
Ratio of heating to grate surface	38 to 1	37.67 to 1	33.5 to 1	24 to 1
Coal per square foot of grate	9.76	10.66	7.25	8.62
Water evaporated per pound of combustible at 70 pounds, feed water 100 degrees	8.77	8.64	8.57	8.79
Water evaporated per pound of combustible at and from 212 degrees of steam of 70 pounds	12.09	11.822	11.923	12.125
Percentage of moisture in the steam	none	2.67	none	0.284
Estimated horse power on basis of 30 pounds of water per hour, 70 pounds of steam, feed water 100 degrees	119.83	135 59	46.96	90.88

From this table it will be seen that the shell boilers' evapora-

tion was better than the water-tube boilers, and the former had less moisture in the steam supplied.

The best comparative tests made between water-tube boilers and shell or horizontal flue boilers was at the estabiishment of the Brush Electric Light Company, Philadelphia, in October, 1882, extending over a period of ten days' actual test.

The Babcock and Wilcox people were anxious to supply the Brush Electric Light Company with boilers, and to show the superiority of their boilers over the ordinary horizontal flue boilers, both kinds of boilers being in use at the latters works, and to convince the managers of the above company that it would be to their interest hereafter to renew their plant with water-tube boilers in preference to the horizontal flue boilers they were using, the test was proposed and conducted.

Babcock and Wilcox agreed to make the test at their own expense and selected Mr. John C. Hoadley, of Boston; the Brush Electric Light Co. selected the writer, to supervise the trials.

CONDITIONS OF THE TESTS.

It was agreed that exactly similar trials should be made of the two kinds of boilers, to wit: two water-tube boilers, rated by the Boiler Company at 75 horse power each, total 150 HP; and three of the horizontal flue boilers of 35 horse power each, total 105 HP.; each set to be tested for three consecutive days, between the hours of 7.30 A. M. and 2.30 P. M., during which hours only three of the engines and three dynamos would be in use, supplying 120 arc lights for actual illumination, and one test light, making 121 in all; and one engine running with throttled steam at less than half speed, driving a dynamo without current and giving no light, merely to be in readiness for immediate use if wanted for an emergency. It was also agreed that two additional boilers should be held in reserve with steam on and fire banked, so that in case of a failure of the others, these might be operated at full capacity and perform the service assigned the boilers on trial. Steam could be taken from the reserve boilers at any moment, if required, so as not to interfere with the light in use during the trial. It was understood that the coal to be used should be of merchantable quality, such as had been in general use prior to the date of these tests in these works.

THE WATER TUBE BOILERS.

These boilers were set in two nests, two in each nest, but had separate furnaces, and could be used either separately or together.

Each boiler contained forty-two tubes of 4 inches outside diameter and 16 feet long, and raking or pitching about 4 feet in this length.

The grates of each boiler were 46 inches wide and 72 inches long, having an area of 23 square feet.

The steam drum was horizontal, 30 inches in diameter and 16 feet long. The water surface in the drum for disengagement of steam was 40 square feet.

When sold to the Brush Electric Light Co., the heating surface of each boiler was stated to be 40 square feet for each square foot of grate surface, or equal to 920 square feet.

The steam from each nest of boilers was conducted to one steam pipe at or near the rear of the boilers, this pipe connected with the main steam pipe which fed the engines.

HORIZONTAL FLUE BOILERS.

There were six horizontal flue boilers set in one nest, so arranged that they could be used singly or in combination; each boiler had a separate steam pipe leading to the engine room. Each boiler was 40 inches in diameter on the front end and 37½ inches on the back end; they being telescopic in form, and 17 feet long, and when in place are 6 inches lower at the back ends; each boiler contained nineteen flues, 4 inches outside diameter and seventeen feet long. The grates were 42 inches wide and 66 inches long, having an area of 19 square feet of surface. The heating surface for each boiler was 435 square feet; the ratio of heating to grate surface being 22.5 to 1.

The water surface for disengagement of steam was 39 square feet for each boiler.

ENGINES.

Each engine was belted separately to a dynamo which, when in full work, supplied electricity for forty arc lights of (nominally) 2 000 candle power, and occasionally an extra "test light," making forty-one.

ORDER OF TESTS.

It was understood and agreed that the first trial should be made with the water-tube boilers, to be followed by the trial of the horizontal flue boilers, each set to take its chance as to the state and condition of the weather.

Previous to the trials the water tube boilers had been out of service six weeks, and had been placed in the hands of the makers' men for repairs and alterations. The furnaces were relined, flues repaired, tubes of boilers scaled inside and cleaned on the outside, and the boilers placed substantially in the same condition as when first erected. Two weeks prior to the trial a fire was kept in them night and day, in charge of two of their old firemen, who also were in charge during the trials.

THE TEST.

The first day's trial commenced Tuesday, October 17, 1882, at 7.30 A. M., in charge of Mr. F. H. Prentiss. The coal on that day was wet, due to the rain falling on it in its transit from the mines; this not being unusual, as the coal cars are not covered, no objections were made and everything went on finely until about 11.20 A. M , when the steam pressure fell to 92 pounds per square inch, and the water in the glass tubes of the water gages was only one inch in height, from the fact of the feed pump having been slowed down so as to allow the pressure to rise, which it finally did, to 95 pounds, at 11.45 A. M., but by running the feed pump at full speed the steam was again lowered to 92½ pounds at 12 o'clock noon, and the water in the gage glass was still falling. The pump was again slowed up, but too late to maintain the steam pressure, which was gradually lowering, as well as the water in the boiler. At 12.55 P. M., steam was so low that connection had to be made with the boilers in reserve, as the steam pressure in the trial boilers was below 90 pounds, and the water could not be seen in the glass tube of the water gage. This ended the first day's experiment.

The boilers under trial required three tanks of water of about 1 000 pounds each, to be pumped into them before the water was brought to the proper level in the glass tubes.

On the following day, October 18, 1882, a second trial was started, and was successful in running the allotted time. Mr. Hoadly was present on this day for about an hour in the morning, he having arrived from Boston at 10 A. M.

He stated to the writer that he was much pleased with the progress that was made so far. He was also present in the afternoon about 3 P. M. At that time account was taken of the waste coal and ashes for the day's run. The coal used was dull looking, but dry.

On the 19th a full day's run was made. Mr. Hoadley was present in the afternoon The coal was dull looking, but dry.

October 20th the run was half an hour shorter than those of the three former days. At 10 o'clock a lot of coal which was quite wet was delivered in the boiler house. At 10.50 A. M., at the writer's suggestion, 100 pounds of the coal was placed on the top of the boiler to dry, as Pat, the fireman, complained about its being wet; his assistant fireman then supplied him with dry coal from a bin on the outside of the boiler house, placing it on the top of the wet coal for the balance of the day. The result was, Pat stopped complaining. The wet coal complained of was only used about one hour. Mr. Hoadley sent a tin apparatus for separating or sampling the coal for analysis. Previous to this, samples of coal were picked by hand from each charge placed on the scales. Mr. Hoadley requested an additional trial, to which the writer assented. On the 21st inst. a fifth trial was started at the usual hour, but owing to Pat undertaking to run with too thin a fire, it burned through in places. Pat, in endeavoring to repair this result produced clinker in other places, by disturbing the thin bed of coal clinker formed by the increased draft at the disturbed parts interfering with the air supply and causing the steam pressure to fall. At 9 A. M. the pressure had fallen to 86 pounds, and the water in the glass tube was out of sight. At 9.10 we were compelled to connect with the reserve boilers, thus ending the fifth trial, for causes as above stated, and under similar conditions to those stated in the trial of the 17th.

During the trial of water-tube boilers the firing was performed by two firemen, one of them opening and shutting the fire-door for every shovelful of coal placed on the grates by the other fireman, who was also assisted at times by Mr. Higgins, acting under the directions of Mr. Hoadley.

HORIZONTAL FLUE BOILERS.

On Monday, October 23d, the experiment was commenced on the three horizontal flue boilers. On account of this being the

first day of the bi-centennial of the landing of Penn, the trials were stopped at 2.30 P. M., more lights being in demand earlier in the day on account of the above celebration, additional dynamos had to be run.

On this day the coal placed on the top of the boilers on the 20th was weighed, and it was found that the 100 pounds now only weighed 92.625 pounds, or a loss of 7.375 per cent., in drying. Time, 72 hours. This was a sample of the wet coal that Pat had complained about and for which he had received dry coal from the ouside coal bin.

One hundred pounds of the dry coal delivered this day was of good appearance, and was placed on top of the boiler; 50 pounds at 10.10 A. M., and 50 pounds at 11.28.

On Tuesday, October 24, it was found that a still greater number of lights would be in demand during the day, and that an additional dynamo would have to be run to supply the twelve lamps needed. Two additional lamps were added on one of the circuits in constant use, making fifteen more lamps to maintain than were used on the former trials. It was also found that the lights usually wanted at 3 P. M. would now be needed earlier in the day, and as a consequence we were forced to end the trials at 12 o'clock noon, instead of running to 2.30 P. M., as was contemplated originally, much to the disadvange of the boilers on trial, due to shortening the time of the run. Coal this day was a fair average sample of the coal used under the water-tube boilers.

Wednesday, October 25th, the same number of lamps and under the same conditions were used as on the preceding day. The coal placed on top of one of the boilers on the 23d inst. was taken down and weighed and found to have lost 2.87 per cent. in drying. Time, 48 hours

During the trials of the horizontal flue boilers the firing was done throughout by a single fireman, unassisted.

The coal used in these trials was delivered at the works each day, with the exception of the coal used out of outside coal bin on 20th inst., as before stated. All the coal came direct from the mines in cars to a siding of the Pennsylvania R. R., and was from there carted and dumped in our presence in the boiler room as the trials were progressing. No objections were made to the quality or conditions of the coal at the time it was delivered by Mr. Hoadley or Prentiss, except by Pat, on the 20th inst., as before stated. Mr. Hoadley's assistants each day selected samples of coal for analysis, as before stated. All of these samples Mr. Prentiss this day passed through the machine furnished by Mr. Hoadley, several times until the whole quantity selected each day was reduced to about 10 pounds; this was divided into two parcels, one for Mr. Hoadley and the other for the writer, for analysis.

TABLE NO. 2.

COMPARATIVE TRIAL BETWEEN HORIZONTAL FLUE AND WATER-TUBE BOILERS AT THE BRUSH ELECTRIC LIGHT COMPANY, PHILADELPHIA, FOR ECONOMY, CAPACITY AND QUALITY OF STEAM.

	Water Tube.	Horizontal Flue.
Date of trial	Oct. 17, 18, 19, 20, 21	Oct. 23, 24, 25
Duration of trial in hours	28.5	16
Pounds of dry coal	13 678	10 315
Pounds of wood	489	319
Pounds of waste	72.5	34.5
Pounds of ashes	3 305	2 523
Pounds of water evaporated	128 601	101 740
Water evaporated per pound of combustible	11.4	12.3
Pounds of water evaporated per hour	5 846	6,507
Efficiency of the boiler in percentage	77.8	84.8
Proportionate efficiency	1	1.10
Percentage of humidity in the steam, per Nystrom	1.6	1.1
Percentage of humidity in the steam, per Hoadley	3.13	1.92
Square feet of heating surface	1 592	1 248
Horse power developed	128.4	137.9

It will be seen that the water-tube boilers were pushed to their utmost capacity, and that in five trials they failed twice to fill the conditions of the test; whereas, the flue boilers ran their three days' trials without a hitch, although the load was over 7 per cent. more than that of the water-tube boilers.

CAPACITY.

The capacity being the evaporation of water per hour.
Horizontal flue boilers........... 6 507 pounds of water.
Water-tube boilers................ 5 894 pounds of water.
Gain in favor of horizontal-flue boilers:

$$\text{Per cent.} = \frac{(6\,507 - 5\,894) \times 100}{6\,507} = 9.42 \text{ per cent.}$$

nine and forty-two hundredths per cent.

QUALITY OF STEAM.

The quality of steam in regard to its humidity:
Horizontal-flue boilers.................... 1.1 humidity.
Water-tube boilers........................ 1.6 humidity.
Gain in favor of the horizontal-flue boilers:

$$\text{Per cent.} = \frac{(1.6 - 1.1) \times 100}{1.6} = 4.5 \text{ per cent.}$$

four and one-half per cent.

RECAPITULATION.

The proportionate qualities of the water-tube and horizontal-flue boilers are summed up from the trial, in which the quality of the water-tube boilers is taken as a unit.

To further show the efficiency of shell boilers the following abstract is presented from a test made in October, 1888, of two shell boilers at the Keystone Watch Case Co., 19th and Brown streets, Philadelphia, by George H. Barrus, consulting steam engineer, Boston, Mass. These trials were made to ascertain what kind of fuel would be the most economical to employ in their large factory.

TABLE NO. 3.

Performance.	Water-tube boilers.	Horizontal flue boilers.
Economy	1	1.05
Capacity	1	1.13
Quality of steam (reciprocal of humidity)	1	1.45
Efficiency of boilers	1	1.09
Efficiency of combustion	1	1.10
Proportional steam pressure	1	1.04
Proportional horse power developed	1	1.08
Proportional number of lights	1	1.08
Proportional horse power per light	1	0.98
Proportional revolution of engine per minute	1	0.98

Table No. 4 gives the dimensions of the different parts of the boilers. Table No. 5 gives the data and results.

TABLE NO. 4.

DIMENSIONS OF HORIZONTAL-FLUE BOILERS: HORSE-POWER, ON A BASIS OF TWELVE SQUARE FEET, SEVENTY-EIGHT SQUARE FEET EACH.

No.	Description.	Dimensions
1	Number of Boilers	2.
2	Diameter of main shell, each, in inches	54.
3	Length of main shell and flues, in feet	17.
4	Length of drum, each, in feet	12.
5	Diameter of drums, each, in inches	36.
6	Number of four-inch flues, outside diameter in each boiler	45.
7	Pitch or rake of main shell, each, in inches	36.
8	Size of grate, each, length in feet	8.
	and width in feet	4.
9	Width of air spaces in inches	0.375
10	Width of bars in inches	0.625
11	Area of perforations through fire door in square inches	4.7
12	Distance of grate to shell, front end, in feet	3.
13	Distance of top of flat bridge to shell, each, in feet	1.
14	Kind of brick setting: Le Van's, with air passages in walls leading to ash-pit	
15	Number and diameter of steam nozzles, each 2	4.
16	Distance from bottom of glass to top of lower shell, in each boiler, in inches	12.
17	Area of grate surface, each, in square feet	32.
18	Area of water heating surface, each, in square feet	934.
19	Area of steam heating surface, each, in square feet	107.
20	Total area of heating surface, each, in square feet	1.041
21	Area through flues, each, in square feet	3.4
22	Area through damper, each, in square feet	2.3
23	Height of iron stack, 72 inches in diameter, lined with four-inch brick, in feet	120.
24	Ratio of water heating surface to grate surface	29.2 to 1
25	Ratio of steam heating surface to grate surface	3.3 to 1
26	Total ratio of heating surface to grate surface	32.5 to 1
27	Ratio of grate to flue area	9.3 to 1
	COLLECTIVE QUANTITIES.	
28	Ratio of surface of grate, two boilers, in square feet	64.
29	Ratio of water heating surface, two boilers, in square feet	1.868

REVIEW OF RESULTS BY MR. BARRUS.

GENERAL ECONOMY OF THE BOILERS.

The degree of economy attained by the boilers is indicated by the evaporations per pound of combustible from, and at, 212 degrees, given in line 23 of Table No. 5.

"I consider that any result exceeding *eleven pounds* is excellent when obtained with anthracite coal, more especially when it applies to the small sizes of coal such as were used on most of these tests. The highest result which I have obtained with anthracite coal is about eleven and one-half pounds, but this occurred with the broken size, which is usually free from slate and clinker-producing qualities. I have not heretofore secured *so high as eleven pounds* with small anthracite coals, but I am not sure that the coals used were of so good a quality as the ones to which these tests relate. The results obtained here are specially good, particularly those of October 3d and 6th, considering that the temperature of the escaping gases is some fifty degrees higher than usually accompanies the most economical work."

"The new condition of the boilers, and *their setting*, doubtless contributed something to these excellent results."

"The results of the test of October 2d, with Cumberland coal, show a low degree of economy. This coal under favorable circumstances will give an evaporation of twelve pounds. I attribute the low result to the fact that too little air was introduced above the fuel for the proper combustion of the gases. The only air supplied for this purpose is that which passes through the perforated linings of the fire-doors, the openings through each of which presents an area of 4.7 square inches, or one-seventh of a square inch per square foot of grate surface. This area is insufficient. In the case of a horizontal-flue boiler, which bore some similarity to this one, the introduction of an increased supply of air through openings amounted to 1.4 square inch for each square foot of grate, was followed by an increase in the evaporation amounting to 6 per cent. I have no doubt that if the area of the perforations in the fire-doors in your boilers had amounted to say thirty-two square inches, they would have given a result with this fuel comparing favorably with the most economical work of other boilers. There is one thing which may have acted unfavorably when Cumberland coal was used. The area of grate surface is too large for securing the best results with this kind of coal. A grate six feet in length would have done better work.

"During the progress of the test the calorimeter was applied to the steam pipe leading to the engine. The indications of thermometer vary from 288 to 297.5 degrees, with a normal reading of 288 degrees at 85 pounds pressure. There was continual evidence here of superheating, and this might be expected from the fact of the steam heating surface, of which the steam issuing from this end of the drum had the benefit."

The results as shown by Table No. 5 were made under this disadvantage, that there was only chimney draft sufficient to maintain a water column of about two-tenths of an inch in height (see Table 5, line 19), whereas, as is well known to all engineers, to burn fine coal, such as used, to advantage, a draft sufficient to maintain a water column of 1¼ inches in height is necessary.

Notwithstanding the disadvantage, however, under which the test was made, the boilers developed, 194.6 horse power, Schuylkill pea coal having been used. (See Table 5, line 14)

The number of pounds of water evaporated with one pound of combustible at and from 212 degrees, was 11.381 pounds, with Lyken's Valley buckwheat coal. (See Table 5, line 23.)

TABLE NO. 5.

DATA AND RESULTS OF EVAPORATIVE TEST OF TWO BOILERS AT THE KEYSTONE WATCH CASE COMPANY'S FACTORY.

	Kind of Coal used.	Lyken's Valley Buckwheat.	Four parts of No. 2 Pea and one of Cumberland.	George's Creek Cumberland.	Lowry's Pea Schuylkill.	Gigg House Washed Pea.
No.	Date—1888.	Sept. 29th.	October 1st.	October 2d.	October 3d.	October 6th.
	TOTAL QUANTITIES.					
1	Duration of trial in hours	10.2	11.3	11.1	11.	10.
2	Weight of wood used in lighting fires, in pounds	185.	231.	300.	225.	283.
3	Equivalent value of wood expressed in terms of coal in pounds	74.	92.	120.	90.	113.
4	Weight of moist coal consumed, including wood equivalent and including slight waste in ashes, in pounds	7 079.5	7 635.	6 489.	8 110.	7 289.
5	Weight of ashes and clinkers and waste coal, in pounds	1 452.	1 427.	507.	1 443.	1 313.
6	Percentage of moisture in coal	2.	3.	3.	0.	2.7
7	Weight of combustible consumed (dry), in pounds	5 487.5	5 982.	5 791.	6 667.	5 782.
8	Percentage of ashes and clinkers and waste coal	20.5	18.7	7.8	17.8	18.
9	Weight of water evaporated, in pounds	59 763.	64 530.	63 112.	70 631.	62 547.
	HOURLY QUANTITIES.					
10	Moist coal consumed per hour, in pounds	696.8	575.7	584.6	737.3	728.9
11	Coal consumed per hour, per square foot in grate, in pounds	10.9	10.6	9.1	11.5	11.4
12	Water evaporated per hour, in pounds	5 882.	5 709.	5 674.4	6 421.7	6 228.
13	Equivalent evaporation per hour, feed water 100 degrees, steam pressure 70 pounds, in pounds	5 346.7	5 184.4	5 158.0	5 837.3	5 661.2
14	Horse power developed on basis of 30 pounds of water from 100 degrees, at 70 pounds	178.2	172.8	171.9	194.6	188.7
15	Equivalent evaporation per square foot of water heating surface per hour, in pounds	2.9	2.8	2.8	3.1	3.0
	AVERAGES OF OBSERVATION.					
16	Average steam pressure in boiler, per square inch	87.3	81.3	86.3	85.5	86.4
17	Average temperature of feed water, in degrees Fahrenheit	203.	204.	204.	204.	204.
18	Average temperature of flue gases, left-hand boiler, in degrees Fahrenheit	388.	426.	450.	420.	430.
19	Average draft suction, left-hand boiler, height of column of water, in inches	0.16	0.2	0.1	0.24	0.27
20	Weather and outside temperature, in degrees Fahrenheit	65 Clear.	65 Cloudy. A. M. Cloudy. P. M. Clear.	65 Fair.	60 Clear.	60 Rain.
	RESULTS.					
21	Water evaporated per pound of moist coal, in pounds	8.441	8.452	9.726	8.709	8.581
22	Equivalent evaporation per pound of dry coal, from and at 212 degrees, in pounds	8.999	9.101	10.472	9.10	9.213
23	Equivalent evaporation per pound of combustible, from and at 212 degrees (with dry coal), in pounds	**11.381**	**11.272**	**11.388**	**11.071**	**11.305**
24	Tons of coal per day for 65 000 pounds of steam, in tons	3.43	3.43	2.98	3.34	3.38
25	Price per ton, including 50 cents for carting, in dollars	3.15	3.05	3.65	3.25	2.90
26	Cost of coal for a day's run of 65 000 pounds of steam, in dollars	10.78	10.46	10.89	10.82	9.80
27	Cost of removing ashes, at 50 cents for 1700 pounds, in fraction of a dollar	0.46	0.42	0.15	0.39	0.40
28	Total cost of fuel and removing ashes for one day's run, in dollars	11.24	10.88	11.04	11.21	10.20

NOTE.—The quantities given for water evaporated are uncorrected for the condition of the steam, whether moist or superheated.

The fact that the percentage of ashes and clinkers and waste coal amounted to an average of *eighteen per cent.* (see Table 5, line 8), is another evidence of the good steaming qualities of the boilers.

"Facts outweigh the profoundest and most ingenious speculation."

From the above trials it will be seen that Mr. Norris did not have the facts before him when writing his "Systematic Boiler Designing." He also refers to "the sectional boiler, with its smaller members and sub-divided steam and water chambers," but does not state about the difficulty of maintaining these chambers steam and water tight. In one boiler house in Philadelphia in which four sectional boilers are located, every Sunday from 200 to 300 joints have to be made steam and water-tight.

Again, as to the priming of sectional boilers. At the Brush Electric Light trials, the water-tube boilers, the heating surface in the tubes was about 672 square feet, and so arranged that the steam enters the relieving surface ($16 \times 2.5 = 40$ square feet) only at one end, and thus reduces the nominal relieving surface to a small fraction for utility, which accounts for the fact that the steam furnished by these boilers was more humid than that of the horizontal flue boilers. The latter have their heating surface evenly distributed under the relieving surface.

The actual relieving surface in each of the water-tube boilers may be estimated as only four square feet for 672 square feet of heating surface. Then the disturbance will be as follows:

$$\text{Water-tube disturbance} = \frac{672}{4} = 168$$

In the horizontal flue boiler the relieving surface was 39 square feet, and the heating surface 428 square feet.

$$\text{Horizontal flue boiler disturbance} \frac{428}{39} = 11$$

Excess of disturbance in water-tube boilers over that of the horizontal flue boiler is as follows:

$$\text{Per cent.} = \frac{168 - 11 \times 100}{168} = 93 \text{ per cent.}$$

ECONOMY.

The economy is determined by the pounds of water evaporated per pound of combustible.

Horizontal flue boilers.................... 12.3 pounds of water.
Water-tube boilers......................... 11.4 pounds of water.

Gain in favor of horizontal flue boilers.

$$\text{Per cent.} = \frac{(12.3 - 11.4) \times 100}{12.3} = 7.31 \text{ per cent.}$$

in favor of the horizontal flue boilers.

POWER OF A BOILER.

The steaming capacity of a boiler is usually expressed in horse power, as with the engine itself, and the horse power is taken to be equal to evaporation of 30 pounds of water, *an evaporation of 30 pounds of water per hour from a feed-water temperature of 100 degrees Fahrenheit into steam, at 318.4 degrees or 70 pounds gage pressure*, which may be considered to be equal to 34.5 pounds of water evaporated from and at 212 degrees. Thirty pounds of water converted into steam, although a convenient unit of measurement so far as the boiler is concerned, does not indicate the power of the engine. The best modern engines exert an indicated horse power per hour with less than 20 pounds of water, whereas some engines largely sold have been found to use over 60 pounds per hour per horse power.

Square feet of heating surface is no criterion as between different style of boilers—a square foot under some circumstances being many times as efficient as in others. In the tests at the Brush Electric Light Co., the horizontal flue boilers developed a horse power for each 9.4 square feet of heating surface, whereas the water-tube boilers required 14.1 square feet, a difference of *33 per cent.*; or in other words, the water-tube boilers required 33 per cent. more heating surface to develop the same power that the horizontal flue boilers required.

* * *

A NEW SPINDLE GRINDING MACHINE.

From time immemorial, almost all taper spindles used in spinning frames have been ground on a cumbersome machine, generally made with a wooden frame and using a grindstone from 4 to 6 feet in diameter and 3 to 4 inches on the face. One of tnese was shown on page 167 in February, 1896. The machine shown herewith, is designed to do the same class of work by using an emery wheel 26 inches in diameter, 1½ inch face, while the entire machine is compact and of very solid construction. In order to obtain the necessary taper to the spindles, the upper table of the machine is provided with a swivel motion, being pivoted in the centre with graduations at the end of the table similar to those on Universal grinder.

NEW SPINDLE GRINDING MACHINE.

The spindle is carried upon centers and is released by the motion of a short lever shown on the tail stock of the machine, the spindle in the tail stock being held up to the work by a spring. A back rest is provided, as this is necessary where the spindles are of very small diameter or of considerable length. The head stock is provided with tight and loose pulley and belt shifter conveniently attached to the same. By means of a large hand-wheel, which is graduated, any desired movement of the emery wheel, may be obtained as fine as one-thousandth of an inch.

The table moves automatically, but may be stopped instantly at any point by pressing on one of the treadles or by hand movement of the lever to which the treadles are attached. A crank permits the operator to move the table by hand. All necessary pump and water connections are furnished. The table is so arranged that all the water is lead back into a siphon tank and is used over again.

The machine in the illustration is for grinding comparatively short spindles, but the manufacturers have made a large number for grinding fluted rolls used in speeder and twister frames, and in some of these machines the table has a travel of 7 feet. Of course one of the chief features of this machine is the use of an emery wheel in place of a grindstone, but it contains many of the best ideas used in practice by the makers of spindles throughout the country. It is made by the Diamond Machine Company, Providence, R. I.

* * *

OBITUARY.

GEORGE B. ROBERTS.

On January 30th occurred the death of George B. Roberts, the well known president of the Pennsylvania Railroad, who had served that company for many years in various capacities, from civil engineer up to president. His rise was gradual but steady, and unlike most similar officials, was not due to any influence except that of recognized ability. He was a hard worker and well liked by all who knew him.

His successor, Mr. Frank Thomson, has also risen from the ranks, beginning as an apprentice in the Altoona shop, and is another example of the excellent system of this road, his selection being in the line of deserved promotion.

* * *

THE EFFECT OF HEAT ON IRON.

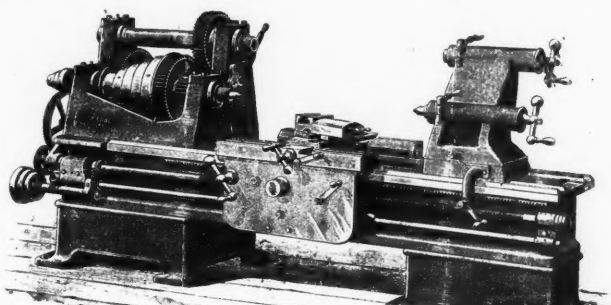
In discussing the working of iron for axles, before the North West Railway Club, Mr. Geo. Hinkers, foreman blacksmith, St. Paul & Duluth R. R., gave utterance to the following which is worth repeating:

"Every degree of heat, in any of its stages, registers itself for good or bad; and if we could note its changes under all of its different phases, we would find that all of its elements and composition bare an affinity more closely than that of iron. Overheating, underheating, overworking and underworking, changes the structure of steel from its natural and proper position more so than in iron. We have proven this with the following results.

Six pieces were forged from the same axle. The first piece was properly heated, properly worked and properly cooled; the result was a perfect piece of steel with a nice texture. The second piece was properly worked but cooled slowly with a yellow heat; result, imperfect texture and a poorer quality. The third piece was heated to a white heat and cooled slowly from a white heat; result, a higher degree of imperfection and much coarser in texture. The fourth was burned in heating and partly restored in structure by hammering; result, a very high degree of imperfection and much coarser in texture. The fifth was burned in the fire; result, valueless for all purposes. Sixth and last operation, was properly heated and overworked, or rather worked too cold; result, very brash, and broke very irregularly, the cold hammering greatly impaired the steel and put in the condition that blacksmiths usually term 'rotten.'"

DOUBLE SPINDLE LATHE.

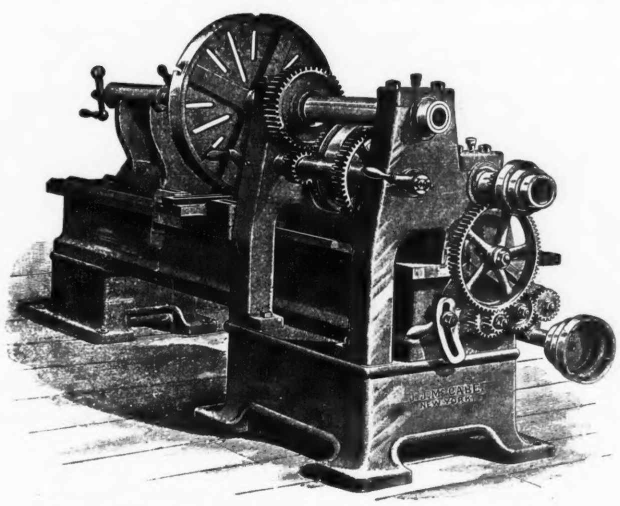
There are many shops where the majority of the work can be done on a 26 inch lathe, but semi-occasionally, or oftener, a job comes along which requiries a much larger swing. This lathe is designed to obviate the customary blocking-up, or the gap bed, and gives two lathes in one, with swings of 26 inches and 44 inches respectively. There were some objections raised to the design as first brought out, a year or more ago, but these have



been overcome by supporting the upper spindle with substantial columns, as shown in the rear view. The tail stock is also well supported by webs as shown.

The front view shows the general appearance of lathe, the upper spindle being thrown in by handle shown on head, which can be done instantly.

It is a heavy lathe, triple geared at a ratio of 22 to 1 and is capable of easily handling large work up to full swing. It has a



wide range of both speeds and feeds. The tool post is rigidly supported, and does not overhang when lathe is doing work at full swing.

Upper spindle makes half the revolutions of the lower, consequently the same gears cut double the pitch on the upper as on the lower spindle. Both together give a wide range of both threads and feeds. It is built for and sold by J. J. McCabe, 14 Dey Street, New York.

* * *

HOW AND WHY.

A COLUMN INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST. GIVE ALL DETAILS AND YOUR NAME AND ADDRESS, WHICH WILL NOT BE PUBLISHED UNLESS DESIRED.

25. G. W. M. writes: 1st. I am getting up a small double cylinder engine of the slide valve type for the purpose of steering a little steamer. The cylinders are 3″ bore × 3½″ stroke, steam pressure 125 lbs. I propose to connect my hand steering wheel directly to the eccentrics, so that the slide valves of the engine are controlled by the hand steering wheel and entirely independant of the engine crank shaft. I propose to let steam follow the piston the entire length of the stroke. My idea is that by this arrangement, when I turn the eccentric shaft by hand in one direction, the engine will follow, and when I stop turning the eccentrics the engine will stop, too. What I fear is that, supposing the engine had such hard work to do, that it ran only at, say 80 revolutions per minute, and I turned the eccentric shaft faster than that, then what? *A.* This need not trouble you. If you turn the eccentric shaft too rapidly the engine will soon indicate it by spasmodic and irregular action, the remedy for which is to turn slower, at once. Doing this, the moving of rudder will be satisfactory if the engine is large enough, so far as such an arrangement is likely to be satisfactory. But the whole arrangement should be such that turning the shaft too fast is not likely to occur. You say that when you stop turning the eccentric shaft the engine should stop. It will, we should say, do so, without question, if the details are such that the rudder itself will not move the engine. 2d. Can any of your readers describe how the engines for steam steering are reversed without any link motion, each cylinder having but one eccentric, and as soon as the steering wheel on deck is stopped the engine stops. I have noticed a brass sleeve sliding upon 3 or more fast feathers set spirally on the shaft that is connected to a rod running into the steam chest, but having no visible connections with the valve stems. *A.* We refer this question to our readers, as you suggest. We do not know, personally, of a steering engine arranged as you indicate. Engines have frequently been made to reverse, using one eccentric only, which has been accomplished by the use of spiral feathers as well as by other means. But none of these devices have become popular for other engines, and we can conceive of no reason for believing that they should become so, for steering engines, in which they say, first considerations are extreme simplicity, and the greatest probability of no derangement occurring. 3d. Do you know of any book that describes these steam steering engines in detail; if so, will you kindly tell me its name, with price and where to get it, and greatly oblige? *A.* We do not know of such a book.

26. L. B. R. asks: Suppose I have a tubular boiler 16 feet long, 5 feet diameter, containing 60 tubes 2½ inches diameter, discharging steam into the open air through a 2½ inch pipe, about how much more coal would it require if the pressure were maintained at 80 pounds per square inch, than if maintained at 40 pounds? *A.* When you speak of pressure per square inch, we understand you to refer to pressure as shown by the steam gage. The actual data in regard to the flow of steam is by no means so complete as would be desirable. It may be answered without sensible error that the weight of steam discharged under the conditions you name, will vary directly as its weight, as per cubic foot, for example. Referring to a table of the properties of saturated steam, a cubic foot at 40 pounds pressure weighs—near enough for present purposes—0.13 pounds and at 80 pounds 0.22. There is a trifle more heat required to convert a given quantity of water into steam at 80 pounds pressure than at 40 pounds, but this is scarcely worth taking into consideration here. We may consider, for present purposes, that the coal burned will be in the proportion of from 13 to 22 pounds for steam at 40 and 80 pounds pressure, respectively. You give dimensions of boiler but do not give the conditions under which the steam is to be used. Unless the discharge pipe is of very considerable length, you cannot keep steam for a 2½ inch discharge at 80 or 40 pounds pressure. For a pipe of inappreciable length, the approximate discharge per minute may be found by multiplying the absolute pressure, (the gage pressure plus 15) by the area of pipe opening, in square inches and this product by 6 and dividing the final product by 7, the quotient being in pounds. The area of the pipe may be taken as five inches, and $\frac{95 \times 5 \times 6}{7} = 407$ pounds discharged per minute, or $407 \times 60 = 24420$ pounds per hour. Assume that your boiler will, at the pressure named, evaporate 8 pounds of water per pound of coal burned. This would require the consumption of $24420 \div 8 = 3052$ pounds of coal per hour, which could not, of course, be burned under a boiler such as you name. As the length of the pipe is increased, or valves and elbows added, the quantity of steam discharged will be diminished. If you throttle the pipe, then the discharge will not be at the pressure named.

27. J. P. C. asks the old question concerning the screwing down of bolts in cylinder-head and then admitting steam equal to strain on bolts. *A.* This has been explained for years by various papers and persons, the general opinion being that there is no additional strain on bolts until the steam pressure exceeds the initial strain. This is not a question which often comes up in actual practice and unless specially requested, do not feel justified in devoting much space to it.

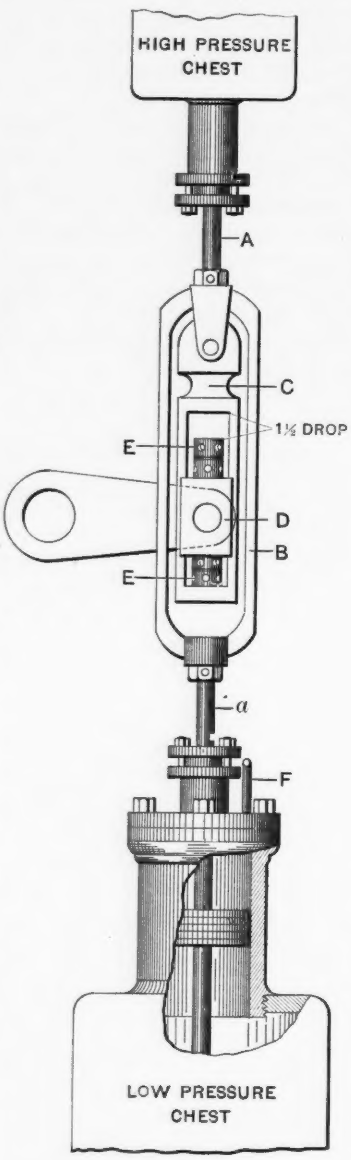
WHAT MECHANICS THINK.

THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE, WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

FIXING A VALVE GEAR.

The accompanying cut and a few words of explanation will show clearly how a troublesome valve gear that was used on a compound pumping engine was forced to quit its foolish actions and to perform its work properly, in a way that was creditable to itself and all concerned. When the engines were first put into operation there was the same style stuffing-box on the low pressure steam chest as that shown on the high pressure chest. The valve mechanism consisted of two slide-valves, two valve stems A *a*, connecting link B, inside link *c*, brasses D and screws E for adjustment, weighing close to two hundred pounds. After the valves and stems became worn a little, the trouble began, of a kind that can readily be guessed.



The engines were of the vertical type; consequently the line of valve travel was the same. The piston and plunger would start on a downward stroke, get half way down and be instantly reversed, due to the valve dropping. To overcome this the parties in charge had a small cylinder fitted with piston and packing made and placed on low pressure chest, as shown in sectional portion of cut. The bottom end of cylinder was always open, allowing the steam to exert a pressure on the under side of piston head. Pipe F was to allow all steam that might blow through to pass out into the exhaust. The inside diameter of the auxiliary cylinder was just large enough so that, with a given amount of pressure, it would just balance the weight of valves, steam, etc.

One might suppose that the valve stems could have been packed tight enough to sustain the weight. That was tried, together with one or two other devices, but nothing except the small cylinders gave complete satisfaction. B. F. AULT.

Martin's Ferry, O.

SMOOTH CUTTING REAMERS.

The question of smooth cutting reamers, which practically keep up to size, has been one on which very much "mind" has been expended, and men who ought to be wise enough to look into cause and effect have resorted to foolish methods thinking to obtain results. To stop "chattering," they say flute the reamer an odd number of flutes, and unevenly divided at that—that don't remove the cause; simply chatters finer. Fluting the reamer, with the "spiral cut," won't do it either. I have used that kind, which were as bad as any I ever saw. For exactly the same reason that a lathe or planer tool chatters, a fluted reamer will make a many-sided hole. A lathe tool chatters because it has too much clearance and not enough "shaving" cut. A planer tool which has too much under side clearance, vibrates as it attempts to scrape off stock. The proper clearance and good, generous cut on tools, shaves off a chip and never chatters.

Now, a word about solid reamers keeping up to size. I have seen as many adjustible reamers for the purpose of keeping to size, perhaps, as any man living, and yet I find they are all far from being perfectly satisfactory for the end desired, especially when made in any sizes under one inch diameter. Now, what is the trouble with many of the solid reamers, which some claim are difficult to keep up to size?

1st. They are not made correctly; so that when the fine outside sized edge (feather edge at that) is worn off, they are under-size; moral—leave enough land so that when edge is dull, by grinding the front of the flute, it cuts as good as new. I speak from experience.

2d. They are usually made of too low grade carbon-steel, and are far too soft after being tempered. Don't be afraid to use high-priced refined steel, three times the price per pound of the ordinary tool steel, and if you work it correctly and temper properly, it won't wear off right away. If it is a hard reamer, I will guarantee that a good lot of work will be gotten out of it before a microscopic inspection will find any of the outside gone.

3rd. If you want first-class service from carbonized steel, do just as little forging into shape and annealing soft, as is possible. Annealing soft usually means the deteriorating of the native carbon, and that means when a tool is hardened it is less related to the diamond, and we all know that the diamond *won't* wear away in size. I make the best of my cutting tools without annealing tools or forging steel if possible; some trouble, but—sure as you live—they get there, and live a good long life up to size.

4th. Use a sizing-reamer simply as a sizer and straightener of hole; remove by the reamer as little stock as is practical.

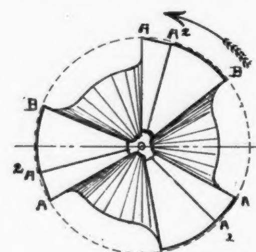


FIG. 1

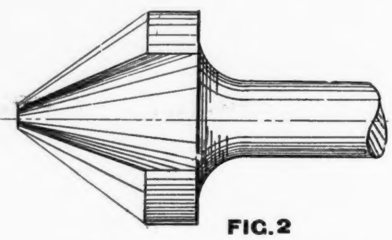


FIG. 2

Enclosed find sketch of a 70 degree reamer I made for a firm the other day, not a thousand miles from here, who, when they get into a hole often give me a call to help out.

The tool which the sketched tool took the place of was an ordinary spiral 12 flute reamer. The purpose for which it was used was reaming a pipe joint seat and, of course, must be round as well as smooth. The old reamer worked badly, and make a bad job. It was no good; so I had a job. The reamer illustrated is a simple straight 3 flute reamer. Fig. 1 is an end view showing the same; A, is cutting edge; A to A^2, is relief from cutting edge; A^2 to B, is circular relief below the cutting circle of edge A, and is simply enough to allow cutting edge to shave; the spaces A^2, B, acted as a rest and a guage of depth of chip. Need I say that the new reamer met all the needs of the job. I will say that it made a smooth, round hole and pleased the firm immensely. Why not? F. W. CLOUGH.

Springfield, Mass.

REAMING HOLES IN PLATE WORK.

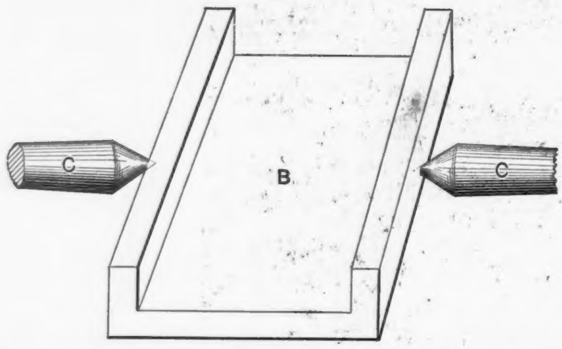
The taper tap used for enlarging holes in boiler-plate, shown by A. H. on page 194 of your January issue, is illustrated in two forms in Figs. 115 and 116 of Grimshaw's "Shop Kinks," (page 135), under the titles of "Screw Reamer for Plate Work" and "Screw Reamer for Boiler Work." A. H.'s type is there recommended for bridge work, and one with much steeper pitch of the spirals for boiler work. REAMER.

A HANDY DEVICE.

The following illustration shows a very handy device for filing and polishing small flat surfaces. Every workman knows from experience how hard it is to file a flat surface so it will not be rounding in center. This device will enable the filing a thin plate perfectly flat, and it can be also polished at same time. C C represent centers of lathe, and the holes in plate B should be deep enough so it will not slip easily from the centers. There should

be no end shake, but at the same time, the plate should swing easily on centers.

The piece it is desired to file should be fastened to B with shellac, or it could be soldered a little at edges. When filing is begun the holder B will swing with the up and down motion of file, and a flat surface will be the result.

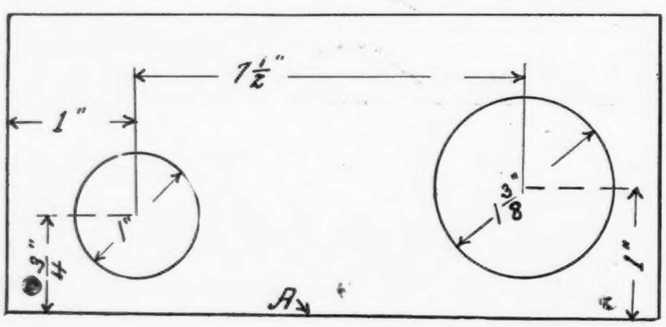


The same principle should be used in filing a square piece, or a slot in round piece, such as a boring bar, tool port, etc.

The sketch is not drawn to scale, as where a large amount of such work is done a variety of sizes would be desirable.—F. H. Jackson.

SHOP PROBLEMS.

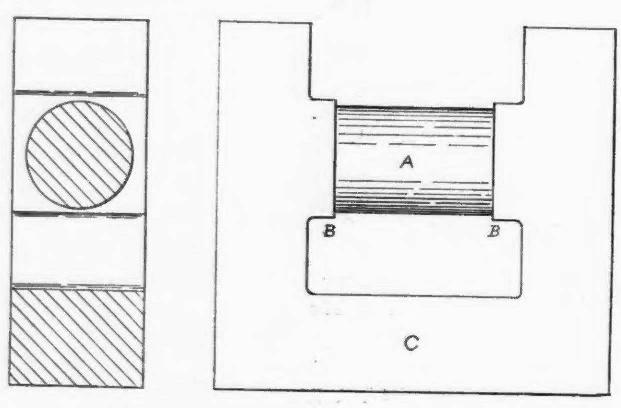
Having a block of cast iron 9½ inches long, 4 inches wide and about 1¼ inches thick, which must have two holes bored to the exact dimensions given in the sketch and must be parallel with the edge A, what is the best practical method of doing it in an ordinary shop not supplied with more than the regular stock of tools? The usual way would probably be to clamp piece in



milling-machine vice and bore a hole (correctly located), and then move the carriage to next position, but is this accurate? Probably a jig would be best, but how shall it be made to comply with these requirements. Jigger.

ANOTHER PROBLEM.

Some time ago you had some problems of a mechanical nature to solve, and I enclose a sketch of a part of an engine which I think will be readily recognized; it is meant for a crosshead.



In this case it was a solid casting in one piece, finished all over and turned in an ordinary lathe at A, with shoulders squared at B B.

Perhaps some of your bright readers might like to think up a fixture in which it was only necessary to start up the lathe, put on the feed and let the machine do the rest. It has been done as readily as if the bridge C or connecting piece did not exist.

Providence, R. I. W. E. Willis.

MANUFACTURERS' NOTES.

The Westinghouse Machine Co. has sold to the Tennessee Centennial Exposition Company, four Westinghouse compound engines, each 400 HP. The engines will be installed in the Exposition Company's power plant. Their Paris agency recently sold four Westinghouse compound engines aggregating 1 100 HP., for electric railway service in Russia.

Messrs. John Steptoe & Co., Cincinatti, O., announce that Selig, Sonnethal & Co., 85 Queen Victoria St., London, E. C., are their sole European agents.

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FRESH FROM THE PRESS.

The Evolution of Automatic Machinery. A. E. Marsh. Geo. K. Hazlitt & Co., Chicago. $2.00.

This is, as the author says in the preface, a brief review of some of the steps of mechanical progress in the manufacture of watches on the American system. It is profusely illustrated with half-tone engravings which, being direct from photographs, are necessarily exact. The small size of the work, and consequently of the machines themselves, make it very interesting to the mechanic; and the fine work of watchmaking, together with the ingenious machinery which enables it to be done automatically, appeals very strongly to him. It is well printed, well bound and will be especially appreciated by watch-making mechanics.

Gas, Gasoline and Oil Engines. Gardiner D. Hiscox, M. E. Norman W. Henley & Co, 133 Nassau street, New York. 350 pages; 220 illustrations. $2.50.

The subjects treated in this book are timely and interesting, as there is no doubt as to the increasing use of these motors, particularly for small powers. It gives such general information on the construction, operation and care of these engines that should prove valuable to anyone in need of such motors, as well as those already having them in use. Among the different phases of the question treated, are: The theory; utilization of heat and efficiency; causes of loss and inefficiency; economy for electric lighting; carbureters; cylinder capacity; mufflers; governors; igniters and exploders; lubricators; management; measurement of power, etc., etc. These are not all by any means, but give an idea of the scope and practical value of the work. It also treats on horseless vehicles and marine propulsion, and appears to be thoroughly up to date in every way. We believe it is the only American book on the subject and it gives, therefore, much information concerning the engines we are familiar with and the conditions met with in this country.

The Mechanical Engineering of Power Plants. F. R. Hutton, Ph. D. John Wiley & Sons, New York; 750 pages, 500 illustrations; $5.00.

The thirty-one chapters of this book are full of information which is sure to be of value to those interested in any of the machinery included in the modern power plant. This was prepared by the author to give such of his students as lacked practical experience with power plants, as good an idea of them as is possible by any book. We cannot begin to name the subjects treated on, as they number nearly 400, and it is difficult to imagine a reader who cannot find nearly all the questions he would ask about this machinery, answered in a clear and interesting manner.

The National Engineer. Official organ of the N.A.S.E. 302 Dearborn St., Chicago, Ill. Price, $1.00 per year.

The initial number of this new monthly has 44 pages and contains much of interest to any engineer. It seems to be a wide-a-wake paper, with practical men as contributors, while Mr. Charles Desmond, who is well known in engineering circles, handles the editorial end of it, We wish it success and trust that it may have a wide circulation.

Friction, Lubrication and the Lubricants in Horology. W. T. Lewis. Geo. K. Hazlitt & Co., Chicago. Paper, 75c; cloth, $1.00.

While this deals principally with lubrication of watches and clocks. the information it contains cannot fail to be of value to those dealing with light machinery of any kind. The proportions of small bearings, from the standpoint of wear and lubrication, are discussed in a practical manner, and in fact the whole book bears evidence of careful work. The author is willing to furnish samples of oil, free, to any one making experimental tests, who will publish such tests or send the results to the author, who is President of the Philadelphia, (Pa.) Horological Society.

Sketches in Crude Oil. John J. McLaurin. Published by the author at Harrisburg, Pa. 406 pages. Price not given.

These are interesting sketches, giving, as they do, many of the incidents of the development of petroleum in this country and abroad. Its purpose, as stated in the introduction, is to give by anecdote and brief narration, a glimpse of this industry and of the men chiefly responsible for its origin and growth. It contains about 250 portraits and numerous other illustrations, which add to the interest in sketches of this kind. Our copy is due to the courtesy of Mr. Chas. Miller, President Galena Oil Works, Franklin, Pa.

ADVERTISING LITERATURE.

THE STANDARD SIZES FOR CATALOGS ARE 9x12, 6x9 AND 3½x6 INCHES. THE 6x9 IS RECOMMENDED, AS THIS SIZE IS MOST LIKELY TO BE PRESERVED.

A. D. QUINT, Hartford, Conn. Catalog of Turret Drills.

This gives a good idea of these novel machines, which are made with spindles varying from two to twelve in number. They are made in two forms, positively driven by bevel gears, (or friction driven when desired) but only the spindle in use revolves. By the use of a patent reversing tap-holder, the machine is admirably adapted for both drilling and tapping within its capacity. Instead of testimonials, the names of users in various lines are given, which is, we think, the better plan. Anyone can get the various opinions on the machine by writing to a user.

NORTON EMERY WHEEL CO., Worcester, Mass. Catalog of emery goods and grinding machinery. 96 pages, 5¾ x 8 inches.

Besides the regular advertising of goods, the catalog contains considerable information about emery wheels, grinders and other shop appliances, which will make it of value to any mechanic. The Walker universal tool and cutter grinder, the Bath Indicator, and a very neat grinding attachment for engine lathes, are among the specialties shown. It will be sent on application.

GOULD & EBERHARDT, Newark, N. J. Treatise on gear cutter grinder.

This is a neat little pocket catalog, or treatise, telling how gear-cutters should be ground, and the advantages of their new grinder (which we illustrated last month) for this work. It describes such details of the machine as interests the mechanic, and should be in the hands of all those who have cutters to grind.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS, Scranton, Pa. Circular of information and testimonials. 1897.

The circular of information contains a description of the courses of instruction in this school, whose reputation is fast becoming worldwide, and gives details of the courses in mechanics and mechanical drawing. Details of other courses can be had on application. A careful perusal of the points treated in the complete mechanical course, should imbue every bright mechanic with a desire to master them, and we are confident no one can invest this money more advantageously than in one of these courses. The book of 1,000 testimonials, give the opinions of students all over the globe, and the name of a student living near them, will be furnished on application. This enables anyone to obtain personal testimony of its merits.

JOS. DIXON CRUCIBLE CO. Jersey City, N. J. Catalogs of Silica Graphite Paint.

One of these is a 24 page pamphlet, giving much valuable information about painting, both as to preparing surfaces and applying paint, the paint in question being, of course, Dixon's silica graphite. The other pamplet gives some very interesting testimonials as to the value of the paint.

AMERICAN BLOWER CO., Detroit, Mich. Catalog No. 30.

This is a finely gotten up catalog of 208 pages, which gives a good idea of the line of fans, blowers, heating and ventilating systems made by this company, together with much data that is interesting and valuable to those who have buildings to heat or ventilate. There is too little attention paid to these features in shops and factories, and much money is lost by not having a shop comfortable for the men.

WM. JESSOP & SONS, Ltd,, 91 John Street, New York City. Wall Calendar.

The card, which is 11 x 14 inches, has a fine photogravure of a country blacksmith shop, the calendar part being below it. It of course advertises the various grades of steel made by this company, which needs no introduction.

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MACHINERY'S REGISTER.

We have quite a complete list of mechanics in various branches of the trade who, judging by the references given, would be valuable men for any shop needing their services. We will mail the names of five men of the kind desired, with their qualifications and references, on receipt of four cents in stamps. In looking around for men to handle your increasing business we think this list will be of value to you. Below are a few samples of the kind of men who are represented:

DRAFTSMAN—

Graduate of Pratt Institute and has had 1¼ years' experience in drawing room of W. & A. Fletcher Co. Marine or railroad work preferred.

DESIGNER AND DRAFTSMAN—

Graduate of Massachusetts Institute of Technology. Has designed power plants, ice plants, power pumps, and can handle any general drafting of outside or inside work.